Volume 8. JUNE, 1894. $2.00 a Year.
Number 4. 75c. a Number.

JOURNAL

OF THE

New England Water Works

ASSOCIATION.

ISSUED QUARTERLY.

PUBLISHED BY
BOARD OF EDITORS.
Junior Editor's Office, New London, Conn.

Entered at the New London Post Office as second-class matter.

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OF THE

New England Water Works ASSOCIATION.

1893–94.

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NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

Vol. VIII. June, 1894. No. 4.

This Association, as a Body, is not responsible for the statements or opinions of any of its members.

ADJOURNED MEETING.

YOUNG'S HOTEL, BOSTON, Feb. 16th, 1894.

The following members and guests were present:

MEMBERS.

Everett L. Abbott, Civil Engineer, New York City; Richard W. Bagnell, Supt., Plymouth, Mass.; Charles H. Baldwin, Boston, Mass.; Lewis M. Bancroft, Supt., Reading, Mass.; George E. Batchelder, Registrar, Worcester, Mass.; Joseph E. Beals, Supt., Middleboro, Mass.; Dexter Brackett, Assistant Engineer, City Engineer's Office, Boston, Mass.; A. W. F. Brown, Registrar, Fitchburg, Mass.; John M. Burleigh, Supt, South Berwick, Me.; George F. Chace, Supt, Taunton, Mass.; William F. Codd, Supt., Nantucket, Mass.; Freeman C. Coffin, Civil Engineer, Boston, Mass.; R. C. P. Coggeshall, Supt., New Bedford, Mass.; Byron I. Cook, Supt, Woonsocket, R. I.; George E. Evans, Civil Engineer, Boston, Mass.; Elmer E. Farnham, Supt., Sharon, Mass.; B. R. Felton, City Engineer, Marlboro, Mass.; Desmond FitzGerald, Supt. Western Division, Boston, Mass.; William E. Foss, Assistant Engineer Boston W. W., Brighton, Mass.; Frank L. Fuller, Civil Engineer, Boston, Mass.; Albert S. Glover, Boston, Mass.; W. J. Goldthwait, Marblehead, Mass.; J. A. Gould, Jr., Engineer Brookline Gas Light Co., Boston, Mass.; E. H. Gowing, Civil Engineer, Boston, Mass.; Frank E. Hall, Supt., Quincy, Mass.; John C. Haskell, Supt., Lynn, Mass.; Horace G. Holden, Supt. Nashua, N. H.; Horatio N. Hyde, Supt., Newtonville, Mass.; E. W. Kent, Civil Engineer, Woonsocket, R. I.; Willard Kent, Civil Engineer, Woonsocket, R. I.; George A. Kimball, Civil Engineer, Boston, Mass.; Horace Kingman, Supt., Brockton, Mass.; Wilbur F. Learned, Assistant Engineer Boston W. W., Watertown, Mass.; William McNally, Registrar, Marlboro, Mass.; Albert F. Noyes,

Assistant Chief Engineer State Board of Health, Boston, Mass.; Joseph K. Nye, Fairhaven, Mass.; Edward H. Phipps, Supt., New Haven, Conn.; George S. Rice, Civil Engineer, Boston, Mass.; Walter H. Richards, New London, Conn.; J. W. Ringrose, Commissioner, New Britain, Conn.; W. W. Robertson, Registrar, Fall River, Mass.; Henry W. Rogers, Supt., Haverhill, Mass.; Daniel Russell, Everett, Mass.; F. J. Shepard, Treasurer, Derry, N. H.; William H. Thomas, Supt., Hingham, Mass.; M. M. Tidd, Civil Engineer, Boston, Mass.; R. H. Tingley, Civil Engineer, Pawtucket, R. I.; D. N. Tower, Supt., Cohassett, Mass.; W. H. Vaughn, Supt., Wellesley Hills, Mass.; Charles K. Walker, Supt., Manchester, N. H.; Horace B. Winship, Civil Engineer, Norwich, Conn.; George E. Winslow, Supt., Waltham, Mass.; E. Worthington, Jr., Civil Engineer, Boston, Mass.; C. W. Houghton, Ashton Valve Co., Boston, Mass.; James M. Betton, Agent H. R. Worthington, Boston, Mass.; A. H. Broderick, Chadwick Lead Works, Boston, Mass.; M. H. Crawford, The Radford Pipe and Foundry Co., Boston, Mass.; F. H. Hayes, Dean Steam Pump Co., Boston, Mass.; Charles H. Eglee, Flushing, N. Y.; A. H. Davis, William H. Gallison, Boston, Mass.; Henry F. Jenks, Pawtucket, R. I.; S. B. Adams, Peet Valve Co., Boston, Mass.; H. L. Bond, Perrin, Seamans & Co., Boston, Mass.; H. H. Kinsey, Rensselaer Manufacturing Co., Troy, N. Y.; W. H. VanWinkle, Anthony P. Smith, Newark, N. J.; F. A. Snow, Providence, R. I.; I. W. Dodge, Standard Thermometer Co., Peabody, Mass.; J. P. K. Otis and G. H. Carr, Union Water Meter Co., Worcester, Mass.; B. F. Polsey and J. H. Eustis, Walworth Manufacturing Co., Boston, Mass.; H. A. Gorham, The George Woodman Co., Boston, Mass.; H. B. Temby, Boston, Mass.; H. D. Winton and J. A. Tilden, Hersey Manufacturing Co., South Boston, Mass.

GUESTS.

William S. Danforth, Plymouth, Mass.; John T. Desmond, Haverhill, Mass.; Frank L. Elkins, Boston, Mass.; George Goodhue, Concord, N. H.; James Gorman, Boston, Mass.; D. D. Jackson, Newtonville, Mass.; James W. Locke, Brockton, Mass.; John Moore, Lancaster, N. H.; J. J. Moore, Hingham, Mass.; Thomas Naylor, Maynard, Mass.; E. T. Spear, Quincy, Mass.; S. H. Taylor, New Bedford, Mass.; William F. Williams, New Bedford, Mass.; H. C. Tower, Cohassett, Mass.

The Secretary presented the applications of the following named for membership:

RESIDENT ACTIVE MEMBERSHIP.

George A. Devlin, Civil Engineer, Marlboro, Mass.
Charles R. Felton, Civil Engineer, Brockton, Mass.
David A. Hartwell, City Engineer, Fitchburg, Mass.
Perry Lawton, Civil Engineer, Quincy, Mass.
Warren B. Wheeler, Assistant City Engineer, Fitchburg, Mass.
William F. Williams, City Land Surveyor, New Bedford, Mass.
Thomas Naylor, Superintendent, Maynard, Mass.
Cornelius F. Doherty, Water Registrar, Boston, Mass.

NON-RESIDENT ACTIVE MEMBERSHIP.

D. A. Reed, City Engineer, Duluth, Minn.
Frederic V. Pitney, Civil Engineer, Morristown, N. J.
W. H. Burr, Prof. Civil Engineering, Columbia College, New York City.
J. Olivier Delisle, Civil Engineer, 443 Dorchester St., Montreal P., Q.

On motion of Mr. Tidd the Secretary was directed to cast the ballot of the Association for the candidates, and that having been done, they were declared elected.

The President called attention to the bill pending before the Massachusetts Legislature, entitled "An 'Act' for the appointment of a State Inspector of Water Meters," and the Secretary read for the information of the members the principal sections of the bill.

Mr. Brackett called attention to the circular to be sent out by Mr. Coffin and requested members to fill out the blanks as far as possible and return them to Mr. Coffin. He stated that the information obtained would be interesting and valuable and would be given to the Association.

Experience talks and papers were contributed by Mr. A. F. Noyes, Mr. Byron I. Cook, Mr. W. F. Codd and Mr. Joseph K. Nye, and the discussions were participated in by Mr. FitzGerald, Mr. Tidd, Mr. Coffin, Mr. Brackett, Mr. Holden, Mr. Ringrose, Mr. Fuller, Mr. Winslow, Mr. Haskell and others.

Mr. Holden asked if it was necessary to remove all loam as well as roots and stumps from newly flowed land in order to secure freedom from bad taste in the water.

Mr. Ringrose stated that in building a new reservoir at New Britain, the muck and roots had been removed but not the loam.

Mr. FitzGerald stated that from experiments made under his direction the conclusion was reached that in ordinary soils the larger part of the organic matter was in the first foot in depth.

[Adjourned.]

QUARTERLY MEETING.

YOUNG'S HOTEL, BOSTON, March 14, 1894 .

The following members and guests were present :

MEMBERS.

Everett L. Abbott, Civil Engineer, New York City; Charles H. Baldwin, Boston, Mass.; George E. Batchelder, Registrar, Worcester, Mass.; Joseph E. Beals, Superintendent, Middleboro, Mass.; Nathan B. Bickford, Supt. W. W. N. Y., N. H. & H. R. R., Old Colony Division, Boston, Mass.; William R. Billings, Taunton, Mass.; Arthur W. F. Brown, Registrar, Fitchburg, Mass.; John M. Burleigh, Supt., South Berwick, Me,; George F. Chace, Supt., Taunton, Mass.; E. J. Chadbourne, Supt., Wakefield, Mass.; Charles E. Chandler, City Engineer, Norwich, Conn.; John C. Chase, Supt., Wilmington,

N. C.; Freeman C. Coffin, Civil Engineer, Boston, Mass.; R. C. P. Coggeshall, Supt., New Bedford, Mass,; Byron I. Cook, Supt., Woonsocket, R. I.; F. H. Crandall, Supt. and Treasurer, Burlington, Vt.; George K. Crandall, Civil Engineer, New London, Conn.; L. E. Daboll, Supt. New London, Conn.; Edwin Darling, Supt., Pawtucket, R. I.; Prof. Thomas M. Drown, Mass. Inst. Tech., Boston, Mass.; Horace L. Eaton, City Engineer, Somerville, Mass.; Frank L. Fales, Lawrence, Mass.; Loring N. Farnham; Civil Engineer, Boston, Mass.; B. R. Felton, City Engineer, Marboro, Mass.; F. F. Forbes, Supt., Brookline, Mass.; Frank L. Fuller, Civil Engineer, Boston, Mass.; George W. Fuller, Biologist, Lawrence, Mass.; Albert S. Glover, Boston, Mass.; J. A. Gould, Jr., Engineer Brookline Gas Light Co., Boston, Mass.; E. A. W. Hammatt, Civil Engineer, Boston, Mass.; George W. Harrington, Wakefield, Mass.; David A. Hartwell, City Engineer, Fitchburg, Mass.; John C. Haskell, Supt., Lynn, Mass.; L. M. Hastings, City Engineer, Cambridge, Mass.; Louis Hawes, Civil Engineer, Boston, Mass.; Clemens Herschel, Hydraulic Engineer, New York City; James H. Higgins, Supt. Meter Dept. Providence, R. I.; Horace G. Holden, Supt., Nashua, N. H.; E. W. Kent, Civil Engineer, Woonsocket, R. I.; Willard Kent, Civil Engineer, Woonsocket, R. I.; Patrick Kieran, Supt., Fall River, Mass.; George A. Kimball, Civil Engineer, Boston, Mass.; Prof. Leonard P. Kinnicutt, Worcester, Mass.; Cyrus B. Martin, Treas., Norwich, N. Y.; Josiah S. Maxcy, Treas., Gardiner, Mass.; William E. McNally, Registrar, Marlboro, Mass.; Thomas Naylor, Supt., Maynard, Mass.; Albert F. Noyes, Assistant Chief Engineer State Board of Health, Boston, Mass.; Edward H. Phipps, Supt., New Haven, Conn.; Dwight Porter, Assoc. Prof. Hyd. Engr. Mass. Inst. Tech., Boston, Mass.; George J. Ries, Supt., Weymouth Centre, Mass.; J. W. Ringrose, Commissioner, New Britain, Conn.; W. W. Robertson, Registrar, Fall River, Mass.; Henry W. Rogers, Supt., Haverhill, Mass., A. H. Salisbury, Supt., Lawrence, Mass.; F. J. Shepard, Treas., Derry, N. H.; Prof. Herbert E. Smith, Yale Medical School, New Haven, Conn.; J. Waldo Smith, Civil Engineer, Montclair, N. J.; George A. Stacy, Supt., Marlborough, Mass.; William W. Starr, Jr., Civil Engineer, Bridgeport, Conn.; Frederic P. Stearns, Chief Engineer State Board of Health, Boston, Mass.; S. G. Stoddard, Jr., Engr. Hyd. Co., Bridgeport, Conn.; Prof. George F. Swain, Mass. Inst. Tech. Boston, Mass.; Charles H. Swan, Civil Engineer, Boston, Mass.; Lucian A. Taylor, Constructing Engineer, Boston, Mass.; William H. Thomas, Supt., Hingham, Mass.; M. M. Tidd, Hydraulic Engineer, Boston, Mass.; D. N. Tower, Supt., Cohassett. Mass.; W. H. Vaughn, Supt., Wellesley Hills, Mass.; Charles K. Walker, Supt., Manchester, N. H.; Warren B. Wheeler, Assistant City Engineer, Fitchburg, Mass.; William F. Williams, City Surveyor, New Bedford, Mass.; Horace B. Winship, Civil Engineer, Norwich, Conn.; George E. Winslow, Supt., Waltham, Mass.; S. J. Winslow, Supt., Pittsfield, N. H.; E. Worthington, Jr., Civil Engineer, Boston, Mass.; James M. Betton, Agent H. R. Worthington, Boston, Mass.; A. H. Broderick, Chadwick Lead Works, Boston, Mass.; F. H. Hayes, Deane Steam Pump Co., Boston, Mass.; Charles H. Eglee, Contractor, Flushing, N. Y.; George A. Taylor, Gilchrist & Taylor, Boston, Mass.; William d'H.

Washington, The Hydraulic Cons. Co., New York City; Henry F. Jenks, Drinking Fountains, Pawtucket, R. I.; S. B. Adams and F. E. Stevens, Peet Valve Co., Boston, Mass.; Harold L. Bond, Perrin, Seamans & Co., Boston, Mass.; W. H. VanWinkle, Anthony P. Smith, Newark, N. J.; H. B. Temby, Repauno Chemical Co., Boston, Mass.; S. D. Higley and E. T. Ivins; Thomson Meter Co., Brooklyn, N. Y.; W. H. Moulton, Union Water Meter Co., Worcester, Mass.

GUESTS.

Hon. Thomas A. Bancroft, Cambridge, Mass.; J. G. Barrin, Civil Engineer, Boston, Mass.; HarryW. Clark, Lawrence, Mass.; C. H. Darragh, Philadelphia, Penn.; George Goodhue, Concord, N. H.; E. Eugene Eglee, New York City; Harry Gould, Troy, N. Y.; T. G. Hazard, Jr., Narragansett Pier, R. I.; F. A. Houdlette, Boston, Mass.; H. J. Jernigan, Fall River, Mass.; James A. Jones, Stoneham, Mass.; Mr. Kieran, Fall River, Mass.; B. J. Reith, Peabody, Mass.; George I. Tarr, Rockport, Mass.; S. H. Taylor, New Bedford, Mass.

The Secretary presented the applications of the following names for membership:

RESIDENT ACTIVE.

J. L. Moore, Supt., Lancaster, N. H.; Daniel D. Jackson, Water Analyst, Boston Water Works, Newtonville, Mass.; Willard T. Sanborn, Supt. Dover, N. H.; Alexander Potter, Civil Engineer, 137 Broadway, New York; Arthur S. Tuttle, Assistant Engineer Water Works, Brooklyn, N. Y.; James A. Jones, Registrar, Stoneham, Mass.; Harry W. Clark, State Experimental Station, Purification of Sewage, Lawrence, Mass.

ASSOCIATE.

National Lead Company, New York City; E. Eugene Eglee, Construction Water Works, New York City.

On motion of Prof. Drown the Secretary was directed to cast the ballot of the Association in favor of the applicants, which he did and they were declared elected to membership.

The President announced that the associate members, although requested by the Secretary to do so, had failed to select anybody to take charge of the exhibits at the next annual convention, and suggested that the Association take some action.

On nomination of Mr. Stacy, Mr. Harold Bond (with Perrin, Seamans & Co.) was selected to represent the associate members at the June convention.

The Secretary read a communication from Mr. Richards the Junior Editor, calling attention to the recent ruling of the Post Office Department refusing admission to the mails of society proceedings at pound rates, and requesting

members to write their respective representatives in Congress in favor of inserting a provision in the Manderson-Hainer bill now pending to include the publications of scientific and educational societies.

He also read a circular issued by the Boston Society of Civil Engineers to their members, on the same subject.

The President then introduced his Honor W. A. Bancroft, Mayor of Cambridge, who made a brief address. The first paper of the afternoon was by Prof. Thomas N. Drown of the Massachusetts Institute of Technology, upon "Electric Purification of Water and Sewage." The subject was discussed by Mr. Stearns, Prof. Smith, Mr. Herschel, Mr. Darling and Mr. Chace.

L. M. Hastings, City Engineer of Cambridge, then read a paper describing some experiments in measuring the flow of water in a 36-inch pipe. Prof. Porter, Mr. Coffin and Prof. Swain spoke upon the same subject.

[Adjourned.]

ADDRESS OF HON. W. A. BANCROFT,

Mayor of Cambridge.

[March 14, 1894.]

The President. I have the honor of introducing to you the Hon. William A. Bancroft, Mayor of Cambridge. (Applause.)

Mr. Bancroft. Mr. President and gentlemen of the Association: I count it a high honor to have the privilege of coming here and facing this solid phalanx of New England manhood, representing as it does the intelligence, the prosperity, and the progress of our country, (for our country does not get very much ahead of New England, and I for one hope that the country will keep up to New England, for this is a standard of which it may well be proud,) men gathered here fit to associate with the gentlemen whose faces look down upon you from these walls, whose cares and responsibilities, to be sure, have ended, but no one of whom I venture to say, no matter how eminent, knew as much about water supply as you do. (Laughter and applause.)

I am here vicariously for one of your honored members, a former president of this Association, a sturdy son of Maine, whom the city of Cambridge long ago inveigled into its service, and which owes him very much more than he owes it, your present Treasurer, Hiram Nevons. I don't know that you feel any anxiety about the condition of the funds you may have entrusted to his care. I wish the funds of this country were in as safe hands as yours are. (Laughter.) No political reference whatever! (Laughter.) But I am sorry that Mr. Nevons is not here. You know his worth, as we know his worth. I wish he were here to join with you. I know the pride he feels in this pioneer association of municipal officials, for such an association it is.

What an object lesson this Association of yours would be to pessimists who are constantly declaring that municipal government in our country is a failure, because of the character of its public service. (Laughter and applause.) But Nevons is not here, and the poor man, I am afraid, is sick. His rugged constitution, which he has impaired, I have no doubt, by his fidelity to the service in which he is engaged, has become somewhat enfeebled. We hope he will regain his wonted health and strength. Such strength as he has he daily devotes to going to our water system, where we are engaged and have been engaged during the winter in some work, showing his fidelity in that way rather than by taking his strength to come in here, which certainly, would be more pleasurable.

I bring, too, the greetings of another water official, I do not know, sir, whether he was a member of your Association or not, the Hon. Chester W. Kinsley who for twenty-nine years was a member of our Water Board, most of the time at its head, and who last winter retired from a service seldom paralleled in this country, in this community or any other, for efficiency, for he was at the forefront of all our Water Board fights, and has succeeded in solving very many of the difficult problems which we have had to encounter in the community in which I live.

The late P. T. Barnum was once asked what he thought his chances for salvation were. He said, "My friend, I have the greatest show on earth." (Laughter.) And when I saw you crowding into this room, and saw your earnest faces, I felt that you too could say that you had a very great show to accomplish anything which you undertook, whether it was an increase in your water supplies or in your salaries. (Laughter.)

This Association is comprehensive, all-embracing, takes in all of New England, I understand. I remember reading not long ago a composition that was written by a small school-boy upon the human body. He said that the human body was composed of the head, which contained the brains, if there were any. (Laughter.) The thorax, which contained the heart and the lungs; and the abdomen which contained the vowels, a, e, i, o and u, and sometimes w and y. (Laughter.) Now, I won't undertake to locate all the brains or the heart of this vast Association; I suppose it is obvious that one, at least, of your guests, ought not to assign himself to that category but rather somewhere in the indefinite part, with the w's and y's; and perhaps you may choose to locate him in the lungs, which represent the wind of such a gathering as this. (Laughter.) It is a very shrewd device, sir, it shows the acumen with which you set about everything you undertake, to get a Mayor to come here to occupy the transition period between the dinner and the intellectual enjoyment which is to follow. The remarks of a Mayor are not usually profound enough to interfere in the slightest degree with digestion, and by the time he is through everybody is ready for the intellectual feast which follows.

I am much interested in the water works, have to be; everybody becomes interested when the occasion arises, as the small boy was, you know, whom the traveler found digging near a woodchuck's hole, and asked if he thought he could get him. And the boy replied, "Why, I have got to get him; the minister, has come and there is no fresh meat in the house." (Laughter.) So I had to find out something about water works after I was elected to office, whether I would or no. During this past year we have found the water works extremely serviceable in Cambridge in taking care of the unemployed. The connection may not be obvious. (Laughter.) I will explain. We had a million and a quarter of dollars to expend to extend our means of collecting water. We are not allowed to use any other beverage in Cambridge, and so we husband this with a great deal of care. When it became apparent that there were a great many men who were out of employment and were willing to work, (at least they said they were willing to work, although it soon became clear that the number who were out of employment and the number who were willing to work was not identical.) (Laughter.) It occurred to us that some of our expenditure might as well be made at once as to be deferred until later in the year. And so we set about the construction of a high service reservoir which we had planned, and we set about filling various unwholesome "vacuums," I think they call them now, we used to call them "holes," (Laughter.) around Fresh Pond; and Hiram had his train of cars up there, and these people went up and he worked them; and I suspect, (Hiram is pretty thrifty and fore-handed, he came from Maine,) that by judicious

adjustment of wages and of hours the City of Cambridge hasn't lost anything by the transaction. At all events we took care of many people, showing that the water works has a function which had not been thought of always before.

I am conscious of the importance of the service in which you are engaged. The conditions of municipal life are altogether different from what they were a generation ago when most of us began to be born. I doubt if there were very many water works in the country at that time ; in the large cities there were, of course. And what is true of water works is true of a very great many indispensible conditions of municipal life, of sewerage, of lighting, of transportation. You cannot get along without these things; there is not room enough in a large city for the people to sleep where they do business. And so all these conditions have changed, and have brought about a changed condition of administration, and you are an excellent illustration of the plan which is proposed by a great many people, whether it will be ultimately adopted or not, I don't know, I mean the plan of having the municipality operate what is sometimes called a "natural monopoly." It is a very short step from the municipal ownership of water works to the municipal ownership of a lighting plant, and from that to the municipal ownership of a street railway. I will not undertake to say that each of these will be ultimately adopted by all of the cities; street lighting has already been to some extent. But the question is asked, if you can run a water works, why can't you run a street lighting plant, and why can't you run a street railway? The question will be determined in the end solely on grounds of expediency, just as the water works question was determined.

We took the water works in Cambridge, I understand, twenty-nine years ago, because the private corporation was not successful in adequately supplying the citizens. The city has been. We have got to that point now, as you must have known from the officials of the city who are members of your organization, where we do not charge the municipality anything for its water; we have a large surplus with which we are either reducing the rates or are making a construction about our reservoirs for the purpose of municipal adornment. In other words, it has been shown there, as it has been shown elsewhere, that it is possible to so operate a concern of this sort that it will be profitable for the community; and the question is asked, as I said, why not a lighting plant, and why not a street railway? And so on. And I am struck, and I believe the people who advocate a plan of this sort would be struck, by the character of the men who compose your Association. I understand, of course, that many of you are professional men, men with technical training, engineers; but the superintendents and the registrars are not necessarily men with a technical training. They are honest men, it is obvious they are able men, they are men with business ability; and it is the object of every one of those men, I take it, to retain his situation. He wants to do towards the municipality just as an individual wants to do towards his clients or towards his customers. He wants to treat it fairly, he wants to give it a full equivalent for his compensation. It is for his interest to keep the standard high. And if that is the motive which operates in the water works, it very justly will be

argued the same thing will apply to other branches of the public service if they are ever taken under municipal control. And it seems to me, I repeat, as I began, that you would be a striking object lesson for anybody who is interested in municipal government. Gentlemen, I see by the seriousness of your faces that you are about ready for the intellectual feast, and I will stop. (Loud applause.)

FILTER AT THE WANNACOMET WATER WORKS, NANTUCKET, MASS.

BY

WM. F. CODD, SUPERINTENDENT.

[Read February 16th, 1894.]

The source of water supply at Nantucket, is a natural pond of about eight acres in extent, and fourteen feet in depth, having neither surface inlet nor outlet, and a very small area of shallow flowage, the shores being quite bold.

The shores and vicinity of the pond are clean, and there is no possibility of sewage contamination, there being but one house within one-half mile of the pond, and the nearest houses of the town are more than a mile distant.

The pond is fed mainly by springs, and the water has always been of very good quality, except in the autumn of some years, when we have been troubled by the growth of *Anabæna*—one of the proteges of the State Board.

In 1891, *Anabæna* appeared about July 15 and stayed with us till October and gave more trouble than ever before. So in the spring of 1892 we constructed our filter, which, as may be seen by the plan, is a circular basin about 64 feet diameter at bottom and 6 feet deep, formed by a level clay puddle bottom 1 foot thick, and an embankment of the same material, having slopes of 2 to 1 and width on top, of 3 feet. Clay puddle was made of three parts clay and one part sand.

In the center is built a circular brick collecting well, 15.25 feet interior diameter and 8 feet deep, having a dome-shaped roof, built of wooden rafters, covered with heavy laths, which were then plastered on the outside and small stones embeded in the cement plastering to make an artistic finish. The bottom is concrete—water tight.

On the bottom and inner slope of the basin was spread a layer of sand one inch thick, to prevent the moving water from coming into contact with the clay.

Then on the bottom is a layer of round and broken stones about 2 feet thick in which are imbedded four lines of 12" vitrified pipe tees, radiating from the well, and from each branch tee lines of 4" vitrified pipes to receive and conduct the filtered water into the well. These pipes are all laid with a slight rising grade from the well, and the joints were packed with a turn of tarred yarn, loosely put in, and each joint was well covered with gravel.

Above the broken stone is a 6-inch layer of gravel and above that the filtering sand, which was put in in three layers and each rolled with a stone roller, the depth, when finished, being from 12 to 16 inches. The surface of the sand is level and has an area of about 4,600 square feet.

The sand was obtained from the shore of the pond, close by the side of the filter and had but very little dirt in it, which was washed out before placing. The sand has rounded particles, varying in size from $\frac{1}{10}$ of an inch down, weighs when damp and packed down as in filter about 103 pounds per cubic foot and has in a given volume about 33 per cent. are voids.

The surface of the sand in filter is about 5 feet above the highest water level of pond and is about on a level with the pump cylinders. It was built when the pond was full of water and if it had been built low enough to admit of running the water from the pond into it by gravity the interest on the extra cost of construction would more than offset the cost of pumping the water into the filter, as it will probably never be used more than two months in a year. Aeration pipes were laid, one coil inside the well, and a branch extending out, inside of every vitrified pipe, under the filter bed. These were perforated with holes $\frac{3}{32}$-inch diameter and 2 feet apart. The intention being to aerate not only the filtered water, but the filter bed itself.

Pond water is pumped through a 6" pipe onto the surface of the sand, and kept at a depth of 12 to 18 inches above the sand. It is intended to filter at the rate of five gallons per square foot per hour.

The filter during the months it is in use is always full of water, but filtration is intermittent, depending on the times of pumping from it.

Filtered water is drawn from the well by an 8-inch pipe, the pumps being about 300 feet distant.

During the year 1892, there was not a day but what the water was all right to deliver to town without filtering, but this year of 1893, the *Anabæna* were on deck again in great numbers, and we commenced using the filter on their appearance August 8. The mode of operation was to pump into and out of the filter at the same time, aerating the water the most of the time while pumping.

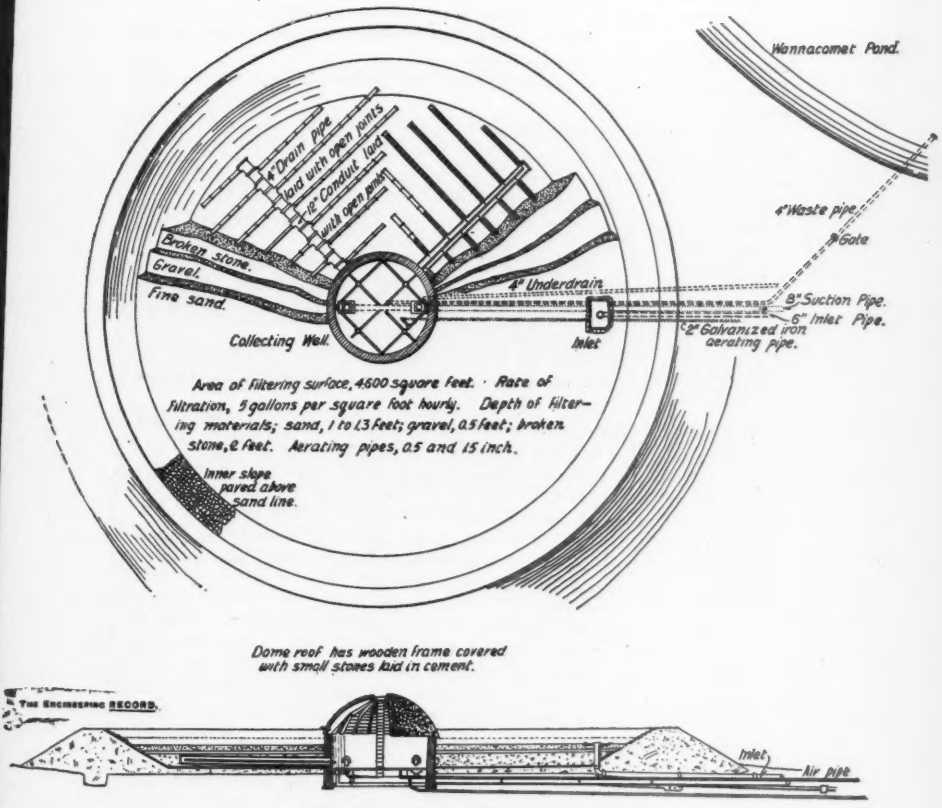
We pumped from sixty to ninety minutes at a time which filled our tank, and then shut down for three or four hours.

The first analysis of water by the State Board of Health, August 14, showed the number of *Anabæna*, in pond water to be 216,000 per 100 c. c. And in filtered water 3,600, or over 98 per cent. removed. Also almost complete removal of odor and color, both of which were strong in the pond water.

We were satisfied with the operation of our filter, but after twelve day's use complaints of odor appeared in town, the filtered water still being clear.

Two days later the surface of the sand became crusted over and almost stopped the flow of water, but it was raked over and broken up and did not clog again. After twenty-two days' use, the odor being so strong, we ceased using the filter, drew down the water and scraped the surface, removing about $\frac{1}{2}$ inch in depth, taking off as little as possible. Most of the impurities were in the top $\frac{1}{4}$ inch, though the sand was stained deeper, in some places as much as 8 or 10 inches.

We found that the air, used in aeration, in passing through the sand had seemed to gether in places, and formed little craters where it came up through the sand, instead of coming up evenly all over the bed. And probably water would find its way down these air passages without much filtering, therefore we disconnected the aeration pipes, extending under filter bed, and did not use them again, but still retained those in the well. We used the filter again September 1 for a few days, but had to give it up as the odor was so strong; and we gave the filter another examination with our constructing engineer,


Wannacomet Pond.
4" Drain pipe laid with open joints
12" Conduit laid with open joints
Broken stone.
Gravel.
Fine sand.
4" Underdrain.
4" Waste pipe.
8" Gate
8" Suction Pipe.
6" Inlet Pipe.
2" Galvanized iron aerating pipe.
Collecting Well.
Inlet
Area of filtering surface, 4600 square feet. · Rate of filtration, 3 gallons per square foot hourly. Depth of filtering materials; sand, 1 to 1.3 Feet; gravel, 0.5 feet; broken stone, 2 Feet. Aerating pipes, 0.5 and 1.5 inch.
Inner slope paved above sand line.
Dome roof has wooden frame covered with small stones laid in cement.
THE ENGINEERING RECORD.
Inlet
Air pipe

FILTER AT THE WANNACOMET WATER WORKS.

and we decided that the trouble appeared after the water had been filtered and before the water reached the pump, on its way to the town, and therefore must be in the collecting well.

We now excluded sunlight from the well, ventilated the roof and aerated the water, but were troubled with odor all through September. From September 29 to October 18, we used the filter without any trouble of any kind—there being no odor—and on October 18 we discontinued its use, as the water in the pound was again all right.

Analysis of October 4 showed reduction of *Anabæna* from 96,800 to 3,800, and color from 0.25 to 0.15.

During the time, between August 20 and September 29, when the odor was worst, the temperature of water ranged from 74° to 62°. After September 29, it was below 60° and we believe the principal, if not the entire, cause of odor was the high temperature of water in the filter well, aggravated by heat from the sun, concentrated by the dome roof, and by warm air pumped in for aeration which was drawn from the engine room.

We propose to alter the roof, or rather build a flat, water-tight, submerged roof, perhaps leaving the dome in place, with large openings through the sides of the dome at and above water level, which will allow air to circulate freely, and the roof will keep the well in the shade.

It is proper to say that the engineer originally designed a flat roof, submerged, but when the dome was proposed, seeing no objections, he consented to its use.

We do not anticipate much trouble the next time *Anabæna* attacks us, if we can keep the water cool. There is an ice house near by from which air might be drawn if there is no danger of germs in it. Our tank is uncovered but as it so small and water stands in it but a short time in summer we do not fear much trouble from that source, though it would be better covered.

The capacity of the tank is 50,000 gallons, and our summer consumption ranges from 150,000 gallons to 220,000 gallons daily. The cost of the filter was $4,800 and it cost to operate it about $90.00.

THE FAIRHAVEN, MASS., WATER WORKS.

BY

JOSEPH K. NYE, SUPERINTENDENT,

[Read February 16th, 1894.]

In 1857 the little village of Fairhaven, situated in the extreme Southeastern portion of Massachusetts, opposite the city of New Bedford, was a thriving, prosperous whaling port. Business was more than good, profits large, and money was plenty. The town boasted a considerable number of wealthy men who gave freely to public benefits, and the solid granite wharves, fine churches and beautiful elm shaded streets, have been handed down as evidence of the prosperity of those good old times. But about this time the great army of whalers met the skirmish line of their enemy—petroleum. The battle that followed was short and it took only a few years to nearly wreck the whole village, not however, until glorious plans for public improvement had been made. Water, sewers, gas, etc., had all been in project, but all went down in the general crash. Water would however have been introduced, had it not been for one difficulty. No water could be found. The town had voted to secure the services of an engineer who should report upon the possibilities of a water supply, and weary from his tramp over dry fields and out-cropping ledges he gave it up in dispair, and reported the idea impossible. In his travels the engineer walked over the spot where now stands the handsome little Pumping Station of the Fairhaven Water Co. Where today we have twenty-six wells flowing over the top of the driven pipe of their own natural head 10,000 gallons per day each. Sometimes great results come from small happenings, and the small happening that resulted in the building of the Fairhaven Water Works was a very wet jacket on a small boy who skated into what they afterwards told him was an "air hole" in the ice on the little Naskatucket brook. The jacket was very wet, but the subsequent warming it got was sufficient to squeeze from it, with the addition of a few tears, a bountiful town supply. The "air hole" proved to be the out-cropping of a large quantity of subterranean water, and in 1893, fifteen years after the above named suffering circumstance, twenty-six $2\frac{1}{2}$ inch tubes were pouring their supply to the surface.

The plant of the Fairhaven Water Works is, of course, nothing more than the usual pump and stand pipe system, but it contains some unusual engineering features that I think will be of interest to the members of this Association. The distribution consists of about fourteen miles of 12, 10, 8 and 6-inch pipe, the plan of the system represents almost exactly the wires of an ordinary toasting iron or grid. The one and one-half mile of 12-inch force main being the handle and the crossing of the 10, 8 and 6-inch representing the wires or grid.

On this pipe we have eighty-six hydrants of the Ludlow pattern, so arranged that we can get four or six fire streams on nearly every building on the system. All hydrants have extra large gate openings and none are connected smaller than a 6-inch supply pipe.

The twenty-six wells are connected into two 10-inch suction lines, running Easterly and Westerly from the station and at the middle point entering a cast iron suction chamber 4 feet in diameter and 4 feet deep. This chamber has a domed top and is connected with the main air pump to remove any collection of air that may be brought in by the water. From the chamber a 12-inch suction pipe is led out to the pump cylinders.

Side by side in our engine room we have two pumps of one a half million gallons capacity each, but of widely different design. One, a regular duplex, compound type with cylinders 12 and 20 inches with 12-inch stroke and water cylinders 12 inches and has a guaranteed duty of fory-five millon foot pounds on a thousand pounds of feed water.

The other pump is a wide departure from the usual design of machinery for a small station and consists of a regular cross compound crank and fly-wheel engine of the Corliss type, with but slight variation from the regular Corliss valve gear. The pump cylinders are placed at the back of the steam cylinders on the same piston rod. Steam cylinders are 15 and 30 inches by 18-inch stroke, both jacketed with live steam. The high pressure exhausts into a receiver placed between the high and low pressure sides which is also superheated by direct steam.

Each engine is fitted with separate surface condensers placed above the pump cylinders and forming a part of the force main.

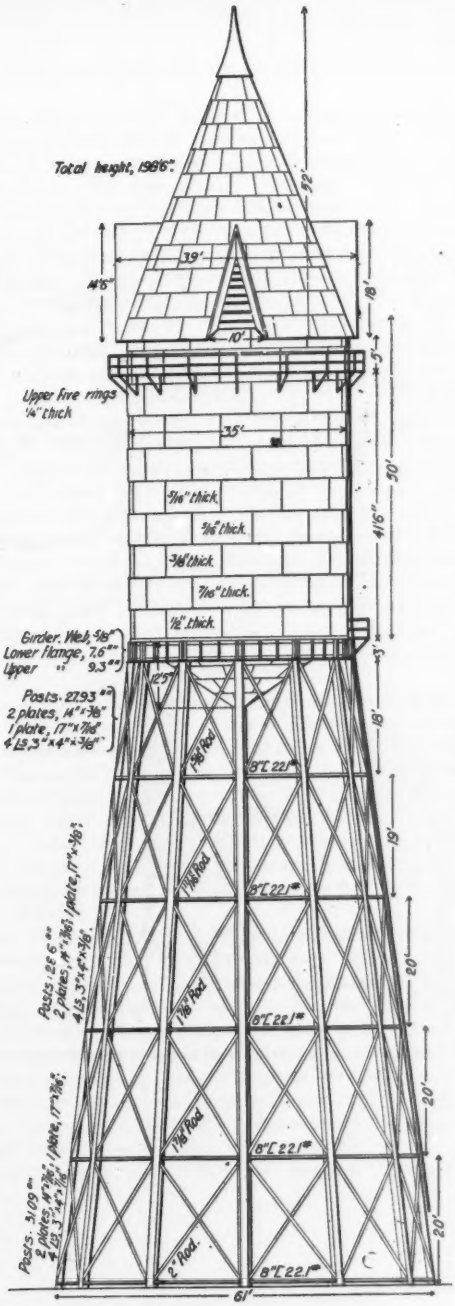
Both condensers are connected to a common air pump discharging into a hot well. The drainage from all of the cylinder jackets and superheater is discharged by means of traps into the hot well which also receives the exhaust steam from the feed pumps.

Both engines were built by the Snow Pump Co , Buffalo, N. Y.

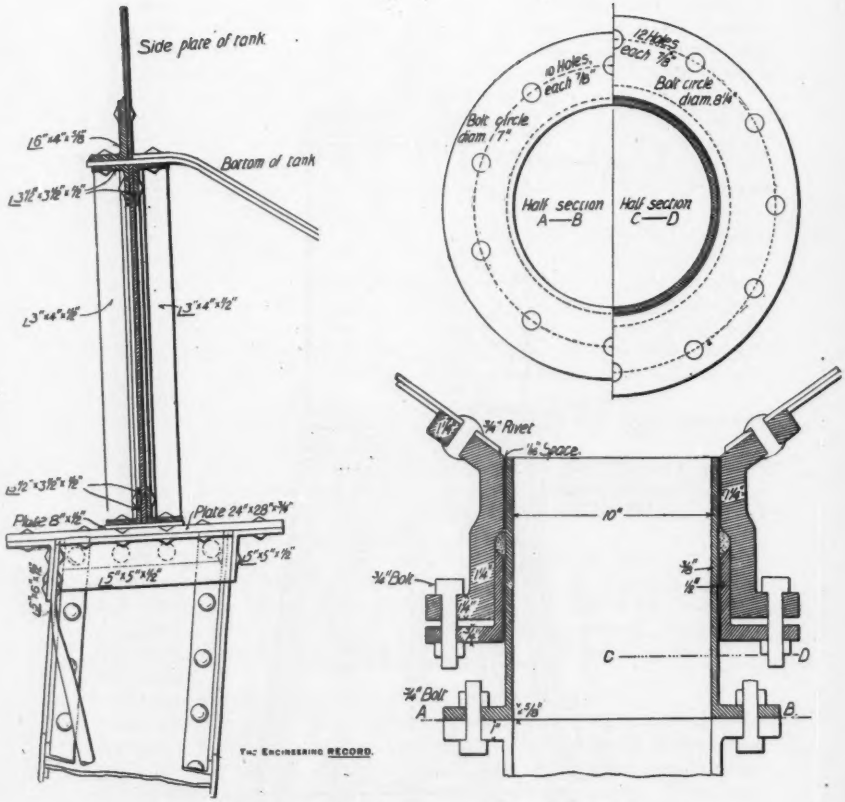
Steam is furnished by two horizontal steel boilers, 60 inches in diameter and 14 feet long, built out of two sheets running the length of the boilers and forming one-half the shell. Horizontal seams double riveted. Each boiler has 100 3-inch tubes and a 32x41 steam dome and carry a working pressure of 100 pounds.

Boilers were built by the Oil City Boiler Co., Oil City, Pa.

Directly on the force main and half way between the station and the town is placed the stand pipe and it is the portion of the work which I think contains the most novelty as there are many new features in its construction. It was designed to meet the local conditions of a level country. It was considered necessary to have the top of the stand pipe 150 feet above the ground at the highest available point, and a stand pipe of that height and 30 feet in diameter, which was the least it was thought best to make it on account of the rapidity with which it would be drawn down in case of fire, would require plates 1 3-16 inches thick in the bottom course and would cost complete with foundations $25,000 or $30,000. One 35 feet in diameter and 150 feet high



STAND PIPE, FAIRHAVEN WATER WORKS.



DETAILS OF STAND PIPE, FAIRHAVEN WATER WORKS.

would require 1⅜-inch plate in the bottom course and would cost not less than $33,000 and probably $35,000 complete. It was finally decided to build a tank 35 feet in diameter and 50 feet high, and support it by a framed steel base 100 feet high. The cost of this is practically $19,000 with foundations and roof. The capacity when full is about 383,000.

The tank itself differs in no way from any ordinary well designed tank or stand pipe, except in construction of the bottom which was made in the form of an inverted cone. This was done to avoid centre supports or cross girders and transfer the strains caused by the weight of water to the outside of the tank where it was supported by the posts. The bottom plates are put in circular rings or courses with radial joints. The roundabout seams are lapped and double riveted, and the radial seams have butt joints with single color plates, and are also double riveted.

The outer course of the bottom plates are ½-inch in thickness as are the lower course of side plates and pass under the latter and project ½ inch beyond the angle iron which forms the connection between the sides and bottom and are riveted to it. The courses of bottom plates decrease regularly in thickness toward the center where the inlet and outlet pipe enters through a composition stuffing box, which allows for expansion and contraction or any movement of the pipe. This pipe is 12 inches in diameter, of wrought iron and secured at two points by braces to the steel frame. Its weight and that of the water it contains are supported in the ground by a heavy casting. There is a balcony around the top of the tank, and a balcony landing at the bottom near the man hole, which are constructed entirely of wrought iron.

The water supply being from an underground source, it was necessary to cover the tank to keep out the light, and a steep conical roof was constructed for the purpose. The sides of the roof make an angle of 63°—26′ with the horizon, or the rise is equal to the diameter. The covering of the roof is of ⅛-inch galvanized plate, lapped and riveted on horizontal courses and riveted to the circular angle iron ribs which form the frame of the roof. There are four dormer windows with ventilating slides made with slats, which raise and lower to give access to the interior. There are also openings for ventilation about the tank under the jet, and at the extreme top by an opening under the base of the finial.

The base is 100 feet high from the coping stone of the foundation to the top of the circular girder upon which the tank rests. It is composed of twelve posts set in a circle, the diameter of which is 35 feet at the top and 61 feet at the bottom. The posts are connected with each other at points 20 feet apart by 6-inch channell iron ties, which prevent the posts from spreading and give them a lateral support at these points, thus reducing the span of the posts between points to 20 feet. The posts are also braced and counter braced at these points by 2-inch steel rods and turn buckles, to resist the overturning tendency of the wind. The ties and braces are all connected together and to the posts by a plate or gussett. The posts are in the form of a plate girder in section, with 17-inch web and 14-inch flanges made up of

plates and angle iron from $\frac{5}{16}$ to $\frac{1}{2}$-inch in thickness, the area of cross section increasing from top to bottom to provide for the increased strains due to the wind at the lower portion of the base. The top of the base is surmounted by a circular plate girder with 36-inch web and 8-inch flanges. This is designed to carry the whole strain caused by the weight of the tank and the water to the heads of the posts which are about 9 feet apart on centres at the top.

The foundation piers, one at each post, are built of rubble masonry laid in cement, and are 9 feet square at the bottom and 6 feet square on top with a coping stone 4 feet square and 15 inches deep, the top of which are hammered to receive the feet of the posts which are a plate 26x28 inches and 1 inch thick. The foundations are designed to bring a pressure of not over three tons per square foot as a maximum when the tank is full and with a wind pressure of fifty pounds per square foot. The earth is a hard pan or clayey gravel. The ground under the tank to the outside of the foundations is to be covered with coal tar concrete to prevent the washing away of the earth around or under the foundation in case of accident to the supply pipe. This stand pipe was designed in the office of M. M. Tidd, by Mr. Freeman C. Coffin, his principal asssistant, and was built by Messrs. Riter & Conley of Pittsburgh.

As everything about the system has been selected, not so much with regard to expense as utility, I think we can safely claim to have one of the best, if not the best, designed and built small systems in New England.

DISCUSSION.

MR. FITZGERALD. I should like to ask if any test was made of the yield of those wells?

MR. NYE. We pumped from them at the rate of about 500,000 gallons a day for fourteen days; that is the only test ever made before we built the works. Since that time we have pumped 1,500,000 gallons in fifteen hours without reducing the head or flow of the wells. This was in a very wet time.

MR. FITZGERALD. In pumping 500,000 gallons a day for founteen days, how much did it lower the head in the ground.

MR. NYE. It did not reduce the head more than three inches.

MR. FITZGERALD. Practically it did not reduce it at all.

MR. NYE. No; it came back inside of three minutes after stopping the pump.

MR. FITZGERALD. What time in the year was it?

MR. NYE. It was in November, and the rainfall had been very light that year.

MR. TIDD. I think Mr. Nye has covered the entire subject. It seems to me, so far as the works are concerned, that they are a success in every way. There are some novelties about the standpipe which may be interesting to members of the Association; and I will say the credit of that design is due principally to Mr. Coffin, who was my assistant at that time, and who substantially designed it. Mr. Nye informs me he was up in it last fall during

one of the severest gales we had, and, as I understood him to say, there was positively no movement felt.

MR. NYE. A very slight vibration inded, but a terrific noise.

MR. COFFIN. I think Mr. Nye's description ot the standpipe covers it completely. I would say it is a design the strains of which can be calculated, as well as in any structure. Although it is a novelty, I think it is designed on correct principles; and, as I say, the strains could all be figured, except there might be a question of opinion as to the wind strains on the bracing, because the posts are set in a circle, and it would be a matter of judgment how many of the sections the wind strain would come on. Of course it would come squarely on two side sections from which ever way the wind blew, and it is a matter of judgment, I should say, how much would be borne by the other sections. Two side sections would not bear anything, of course.

The first design was made with the posts of Z bar columns; but on consulting with the builders they said that at that time, it was almost impossible to obtain Z bar columns from the mills in any reasonable time, and that they cost more, and suggested the form it was put into with one plate girder; and although it is probably not quite as economical a form of material as Z bar columns, and we made them a little heavier than we would have with Z bar columns, still I think possibly it may be as well. The girder at the top is 39 inches deep. It is a circular girder, made very much like a plate girder, except that in plan it is circular, and all the weight of the water in the stand, pipe comes upon this it, and is transferred to the heads of the posts which are 9 feet apart on centres; and the girder was figured to carry that strain.

The great object, of course, in making this standpipe in this shape was the saving in cost. It was so high that a standpipe of the same cost probably would not have been more than 18 or 20 feet in diameter. I don't know as I have looked into that with sufficient care to state positively; but a standpipe of this same character, carried to the ground as a standpipe, would have cost nearly twice as much as this one did, without the foundation and without the roof. That is the advantage, in this form, namely: the saving of money. It is a novelty, of course, and I am naturally interested to see how it comes out.

MR. BRACKETT. I should like to ask Mr. Coffin if there is any question in constructing a standpipe 150 feet high, of the practical use of the very heavy plates which are necessary, that is in the manufacture; having in mind, perhaps, the accident at East Providence?

MR. COFFIN. I should not want to speak positively about a thing of that kind, but it seems to me I should avoid using plates heavier than one inch, especially if all the seams were to be made lapped seams. For where three plates come together, as they do where the longitudinal joints are lapped and then a vertical joint laps on to them, there is a corner which has to be beaten down, and that has to be heated in place by some kind of a basket heater, and it seems to me it must occasion some severe strains.

Then there is another point. I don't know how the rolling might affect such thick sheets. Of course in a standpipe of that diameter there would

never be very much strain, perhaps; and it is my opinion that certainly all sheets above three-quarters of an inch should be drilled instead of punched, because the drilling would not affect the structure of the iron or steel. The tank part of the standpipe was designed to be of iron; in fact it was designed to be all of iron, except the posts, the compression members. I think, as I said before, all plates over, three-quarters of an inch should be drilled instead of punched; and, I should want to avoid using plates over one inch thick.

MR. NYE. I would like to say the wells in our system were driven under the direction of Mr. Daniel Russell.

MR. TIDD. This standpipe was constructed of iron, and I have always preferred iron to steel from the fact I had rather have the best quality iron than the very poorest quality of steel. I have noticed that all the standpipes in the country that have fallen have been of steel, while I know of no instance of an iron one falling.

MR. COGGESHALL. I would say one word about the appearance of this stand pipe. Most standpipes are blots on the landscape, as we all know, but this on the contrary, is a very sightly structure as we see it from New Bedford.

THE ELECTRICAL PURIFICATION OF WATER,

BY

THOMAS M. DROWN, M. D., Institute of Technology, Boston, Mass.

[Read March 14th, 1894.]

In this "Electrical Age," when a new application of electricity to every-day needs is a matter of daily experience, it does not surprise one to hear of the practical use of electricity as a purifying and disinfecting agent, particularly as we are accustomed to think of it as a force which purifies as well as destroys.

The electrical purification of water and sewage appeals to most persons therefore as a process likely to be both potent and effective. There is, moreover, to some minds a peculiar satisfaction in the contemplation of a subtile force which acts in a mysterious way, and to such minds an explanation is often an unwelcome disillusion.

Inasmuch as considerable prominence has been given in the last decade to methods of electrical purification of water and sewage, it may not be uninteresting to state briefly just how this purification is effected, and the principles on which it rests.

We may distinguish two classes of so-called electrical purification : — First, those which electrolyze water, liberating oxygen at the positive pole ; and second, those which electrolyze a solution of common salt and liberate chlorine in the same way.

The Webster process for the purification of sewage, of which a good deal was once heard, belonged mainly to the first class, although by reason of the chlorides contained in the sewage, it fell also, in part, into the second class. The oxygen liberated at the positive pole, while in the nascent state, was supposed to oxidize some organic matter, but as the pole was composed of iron plates, the oxygen was mainly consumed in oxidizing this iron, and the oxide of iron thus formed acted as a precipitating agent on the sludge in the sewage. This process was, thus, mainly one of chemical precipitation of sewage by means of oxide of iron, which was formed by a current of electricity passing through the sewage. Much was hoped for from this process, but it never passed, as far as I am aware, beyond the experimental stage.

The possibility of oxidizing organic matter on the large scale by means of nascent oxygen liberated from water by the electric current will probably never be more than a dream. Attractive as the process seems, the necessary conditions for accomplishing it could probably never be realized on a city's water supply or on its sewage.

One word in this connection about the "nascent state" of an element, of which we hear so much now-a-days. It is a well-known chemical fact that elements just liberated from combination are much more active than in their

ordinary condition. Nascent hydrogen, for instance, is a powerful reducing agent, nascent oxygen a powerful oxidizing agent – properties which are lost when these elements have assumed their molecular condition.

In some of the recent literature which I have read on the electrical purification of water, I have come across the idea that a nascent substance is one that is "fresh," in contradistinction to one that is "stale"; as if, for instance, oxygen liberated from water a minute ago would be more active than if it had been formed one hour. This is very wide of the mark — it is only at the very instant of formation that an element has enhanced powers due to its nascent or new-born condition.

The more recent systems of purification of water and sewage by electricity belong in the second class, that is, the decomposition, by electrolysis, of a solution of common salt. When a solution of salt (chloride of sodium) is decomposed by electricity, we have sodium liberated at one pole and chlorine at the other. The sodium is immediately oxidized and combines with the water present, and a solution of caustic soda results. By suitable mechanical contrivances the chlorine gas may be conducted away from the other pole as fast as liberated and collected as such. This method of making caustic soda, it may be said incidentally, is yet more or less in an experimental stage, but it seems not unlikely that the electrolytic production of caustic soda from common salt may become one of the world's great industries.

But if, instead of separating the caustic soda and chlorine from each other in this process, they are allowed to recombine, we have a complicated series of reactions resulting in the formation of various products dependent on the concentration of the liquid and its temperature. The principal product under ordinary conditions is sodium hypochlorite, variously named — chlorinated soda, chloride of soda, and in pharmacy, as Labarraque's solution. A corresponding and entirely analagous compound is the so-called chloride of lime or bleaching powder, in which lime takes the place of soda.

This, then, is the substance, sodium hypochlorite, with which we have to deal in the method of electrical purification which depends on the electrolysis of a solution of salt or sea water. When the current of electricity has, in the manner above described, formed a sufficiently concentrated solution of sodium hypochlorite, this solution is mixed with the water or sewage to be purified.

I would remark, first, that there is nothing new in the application of electricity to produce the hypochlorites, except so far as the introduction of the modern dynamo enables us to generate electricity at a much less cost than formerly, and consequently to use it economically in industrial chemical operations.

Second, there is nothing new in the use of sodium hypochlorite as a disinfectant, deodorizer and germicide.

In the very valuable Report on Disinfectants, published by the American Public Health Association in 1888, the hypochlorites were shown, experimentally, to be among the most effective of all disinfectants in their action. One per cent. of a solution of sodium hypochlorite containing six per cent. of

available chlorine, destroyed the Bacillus anthracis in two hours; two per cent. of this solution was effective in thirty minutes.

Of the corresponding lime salt, or bleaching powder, the committee reported that a solution of this substance, containing twenty-five per cent. of available chlorine, was effective in a one-per cent. solution in one or two minutes, and that a solution of one-fourth this strength would kill Bacillus anthracis and Bacillus subtilis in two hours.

The two hypochlorites of sodium and calcium were thus shown to be equally efficacious, the activity depending on the amount of hypochlorous present, or, in other words, of available chlorine.

The so-called electrical purification of water, by treating it with an electrolyzed solution of salt, is thus seen to be simply a process of disinfection by sodium hypochlorite; electricity, as such, has nothing to do with it. There is nothing peculiar in the sodium hypochlorite produced by electrolysis; it has no different properties from that made by the ordinary process of passing chlorine into a solution of caustic soda. That other compounds are formed in small amount by the action of chlorine on caustic soda is true, but it has not been shown, nor is it probable, that any one of them has as potent germicidal power as the hypochlorite.

Ozone is generally supposed to cover a multitude of sins of polution and quietly to destroy them; but we do not know much, if anything, about its germicidal power; and there is certainly no good reason for attributing any of the disinfecting action of an electrolyzed salt solution to ozone, even did we certainly know it to be present.

It is unfortunate, I think, that the advocates of this system of purification of water and sewage are not content to attribute the purifying action of the electrolyzed solution of salt solely to the hypochlorite formed. There is nothing gained by calling it "electrozone" or an "electro-saline solution," for there is nothing mysterious about its action, as these terms would lead one to suppose. Nor is it proper to speak of this system of purification in any sense as an "electrical" one.

If one were to purchase two bottles of sodium hypochlorite of identically the same composition, one prepared by a chemical process and the other by the electrolysis of a salt solution, he would not expect to find them called by different names. To call the latter an "electrical disinfectant" would be simply fantastic.

Finally, is it desirable in any case to treat a city's water supply with a powerful disinfectant like the hypochlorites? When the question is put in this bald form I cannot think it will receive the approval of engineers and sanitarians. Leaving out of consideration the difficulties and cost of disinfecting effectively and uniformly the water supply of a large city, the idea itself of chemical disinfection is repellent. Every city should jealously guard its water supply; it a sin against decency and good morals to permit the polution of drinking water by sewage and house drainage. It is a still greater wrong (not to say a foolish blunder) to permit the open polution of its drinking water streams, and then systematically to disinfect them.

In cases where a water supply has got into such a hopelessly bad condition that nothing will render it safe but disinfection by chloride of soda or chloride

of lime, it is high time, I think, to abandon the supply; and in this opinion I feel sure most water works engineers will coincide.

DISCUSSION.

MR. STEARNS. I would like to ask Prof. Drown if he has figured the quantity of salt or hypochlorite that would have to be used in any operation of this kind?

PROF. DROWN. No, but the amount could be calculated from the figures I gave. It did not seem worth while to discuss a subject of this kind on the basis of cost, since the idea of the disinfection of a water supply by chemicals is to my mind faulty in conception. Yet I think it may be said that the amount of hypochlorite necessary to thoroughly kill all the germs in a water supply of, say, fifty million or one hundred million gallons a day would be found to be very large, on the basis of the figures given by the committee of the American Public Health Association.

PROF. H. E. SMITH. There is a question I would like to ask Prof. Drown. The solution which has been in use at Brewsters I have had occasion to analyze on several occasions, and it contains such a quantity of hypochlorite of sodium as corresponds to about .25 of a part of available chlorine in 1000, that is .025 per cent of available chlorine, although it is prepared by electrolizing a solution of from two to three and one-half per cent; that is the amount of chlorine which is in this solution in available form is about one part in sixty-five or seventy of the total chlorine. Now the point which I would like to ask Prof. Drown is with regard to the application of this method to the purification of sewage, not of drinking water, for I fully agree with him that we don't want to take dirty water for this purpose, and clean it before using. Does Prof. Drown think that such a solution, of the strength which I have mentioned, and the strength which they are using there, would have any efficatious oxidizing power on the sewage, or would it act only as a disinfectant? If only as a disinfectant, of course, ultimately if the water is not greatly diluted it would undergo putrid decomposition. My question therefore is whether this amount of available chlorine would amount to anything as an oxidizing agent, or whether it is simply useful as a disinfectant to delay decomposition for a time.

PROF. DROWN. I regard the electrolysis of water liberating oxygen, and the electrolysis of salt solution liberating chlorine, as both insignificant in actual power of oxidation of organic matter in water, under the conditions of ordinary practice. Some forms of easily oxidized organic matter might possibly be oxidized in this way, but to any large extent I think it has never been shown to be the case. All the attempts at treating sewage by oxydizing agents in England have shown the impracticability of this process. I regard all these chemicals of value simply as germicides, and not for the direct action on organic matter.

MR. HERSCHEL. I am a little disappointed by the professor casting cold water upon the idea of, or discouraging the purification of drinking water by any means that at all would promise success. The proposition, as it has been put here, is that it is a horrible thing to allow drinking water, first, to become defiled and then to purify it. But as far as the defilement of water goes, we can not practically prevent it; that is being attended to without any

effort on our part, and being attended to only too well. There are those of us in this room who can remember when a drink of Cochituate water was a good thing to take; the rule is now it will turn your stomach. The time was when the Croton supply was considered very good drinking water; it is now barely fit to drink. And so I might go on and speak with reference to a great many other waters which at one time were very good and have become very bad. Now, the mere description in reports and catalogues, and the giving of these wonderful names to the substances, to the animalculæ and the various vegetable matters that are found in these waters, does not tend to purify them. When we classify all these bacilli and algæ, all these animals and plants, and name them, misroscope them, lithograph them, that does not purify the water. This is a practical association. It is not merely pursuing science for science's sake. Its object is not merely to know what is in the water that is harmful. I take it the object of this Association is to get rid of that stuff. Why should there be any cold water thrown on an attempt of people to purify such water? The polution of it is all the time going on, and we cannot wholly prevent it. Railroads run into the territory of the watersheds, population increases in the territory, and we cannot keep it out. You can't keep these drainage areas without getting a poluted supply, and I class the Sudbury right with them; for the Sudbury drainage area, we may say, is too densely populated to-day for giving a proper supply of water, and so is the Cochituate. That is the sum and substance of it all; that is the reason the water is not as good as it was. It is because the population is now too dense.

Now, what are you going to do about it? That used to be a political inquiry, but there is a great deal of truth in it. What are you going to do about it? That is a practical question, and it is not asked with any taunt in it. It is a question that will have to be answered — What are you going to do about it? You cannot take these people by the nape of the neck and kick them out of their houses and homes and depopulate the whole drainage area. Why therefore should we not welcome processes which are gone into for the purpose of purifying water? Certainly just as much argument can be made against the processes of purifying the sewage of these people, as against those for purifying the water which, in spite of all that has been done, is still not as good as it was. Why should the Professor make objections against processes for purifying water, the very thing we have all been waiting for and what we want done? I don't want these remarks of mine to be construed as arguing in favor of the electrical purification of water, mind you, for I know very little about it. I came here to-day largely to hear what the Professor had to say, and with the hope that perhaps there was something in it. I am disappointed because from the tone of his closing remarks, it would appear that he discourages the whole idea. He says we don't want to go to purifying water; we want it pure to begin with. Well, when the millenium comes, we will have pure water, and perhaps it will stay pure; but at present, I want to hear a word of encouragement for anybody and everybody who will attempt to purify water in some practical way.

Mr. Darling. Mr. President, I am glad that Prof. Drown has hit the nail right on the head, for I think he has. I think he has come to-day and told us

just what we want to do. He says that when a water supply gets so impure it has got to be treated to make it good, it is time they looked for another source, and I think he is right about it. The only way to get pure water is to stop the impurities from going into it, and if there is a place which gets water from a source of supply where the impurities cannot be stopped from going into it, it is high time another source of supply was obtained. I suppose that in most cases the drainage of sewage into the source of supply can be stopped. We know that many cities and towns have been compelled to divert their drainage from the rivers, and I don't see any other way to prevent the trouble. I am glad, as I say, that Prof. Drown has told us the naked truth about it. He has certainly hit the nail on the head this time.

MR. HERSCHEL. We have here a case where bacilli and algae are to be hit on the head, not nails. The gentleman has a city for a neighbor in which some system of the sort is badly enough needed. What is Providence going to do about getting water that is fit to drink? They can't drink the water they have there; they have to buy it by the gallon if they want water fit to drink. They can't afford to abandon all their works, and why shouldn't they purify the water? And what greater objection is there to purifying it by chemical means, than there is to filtering it? It is only another method of purification.

MR. DARLING. I will answer that question. We are told that in the city of Providence, after the water has passed some four or five miles down the river, it purifies itself before it gets to the pumping station. [Laughter.] We are told that aeration of water over dams purifies it; that water purifies itself in running such a distance. Now, then, if the city of Providence will cut off the cesspools, and I understand she got rid of quite a lot of them last year, and she has been doing it for a number of years past; if she will stop the sewage from getting into the river, there won't be any trouble with the water. Or if she will go up, perhaps into Burlville, and take a new source of supply, she can get practically pure water there. The city of Boston, I expect, at some not distant day, will take her water from up in New Hampshire.

MR. WALKER. She can't do it. [Laughter.]

MR. DARLING. The city of New York is buying up the whole watershed that surrounds her supply; she is going to control the whole of it. The gentleman from New Hampshire says Boston can't do it. They have got more water up in New Hampshire than they know what to do with now; they don't use but little or it. And I may say to my friend that he has got to look out for the protection of his source of supply. The city of Manchester has got to look out for her source of supply, or else it will soon become so polluted that it will need to go somewhere else to get its water, for people are building all around it now. The only way to do is to protect our present sources, and it can be done if we will only put our shoulders to the wheel. Massachusetts is doing, through her State Board of Health, what other States have got to do. She is doing one of the grandest works that can be done, that is, stopping the pollution of water supplies. And that is what Providence has got to do, or else she must get her water from some other source.

MR. CHACE. I agree with Mr. Herschel, that it is desirable to know all we can about the purification of water, and I understand from Prof. Drown's paper that, as a practical matter, purification of water by electricity is a humbug.

SOME MEASUREMENTS OF THE FLOW OF WATER IN A 36" AND 30" COMPOUND PIPE.

BY

L. M. HASTINGS, City Engineer, Cambridge, Mass.

[Read March 14th, 1894.

The measurement of the flow of water in pipes is a matter of great interest to engineers and persons connected with water works.

Almost countless experiments have been made by American and European investigators, from M. Chezy in 1775 to the present time, to determine the ratio of the theoretical to actual discharge of pipes of different diameters, heads, and degrees of roughness, so that for ordinary conditions and sizes, the "coefficient of friction" is now pretty well determined. The opportunity to measure the flow in a compound pipe of large diameter and great length is not so easily obtained.

This may be my excuse for referring to the comparatively few measurements which I was able to make in endeavoring to determine the flow of water in the conduit pipe connecting the Stony Brook Basin with Fresh Pond, of the Cambridge Water Works.

As is probably well known to you all, Fresh Pond is situated just within the westerly limits of Cambridge, and Stony Brook, from which the additional supply is drawn, is about eight miles distant farther west and empties into Charles River.

Five thousand and ten feet of the conduit at the westerly or Stony Brook end is of 36" pipe; the remainder 34,340 feet is of 30" pipe. the head or fall from a full basin at Stony Brook to Fresh Pond is 64 feet. The pipe follows a profile as shown on the accompanying sketch, (Fig. 1) and is unfortunately high at the pond end, rising some 28 feet above the hydraulic grade line. This rise causes a constant collection of air at the high points, and probably reduces the flow. It also seems to render the operation of the 30" gate at Fresh Pond difficult, as the large column of water standing so near the vacuum line causes a surging and commotion in the pipe at the opening or shutting of the gate.

It was in the gate house at Stony Brook that the measurements were made. The 36" pipe in passing through the wall at the gate house and opening into the effluent chamber, is enlarged to a "bell mouth" the diameter of the end or bell being 46", this dimension being obtained by dividing the diameter of the pipe (36"), by the well known factor ,785, intending to give the end of the pipe, the form of the "contracted vein" of a jet of water.

The measurements were made with a "Fteley & Stearns" current meter as made by Buff & Berger of this city city. The meter was placed on the end of a rod, so that it would move on a horizontal diameter from one side of the pipe to the other, it being attached to a vertical rod or pipe, pivoted in the center, the upper end of which rod came above the floor of the Gate House.

By moving this upper end of the rod the meter at the other end could be

made to travel across the pipe in a horizontal line. The stem of the small pinion of the meter had a cam attached which at every revolution raised a light spring, which snapping back as the cam passed, made a distinct vibration, or tick, as it struck the end of a small wire, which wire was carried up through the vertical pipe to the floor above, and ended by being soldered to an empty baking power can which served as a "sounder." With this simple apparatus the blows of the "ticker" could be distinctly heard and counted from under more than 30 feet of water. By timing the number of blows per minute, the number of revolutions of the wheel could be determined and having the "rating" of the machine, the velocity of the current of water in the pipe below, could be easily ascertained.

The accompanying diagram (Fig. 2) shows the results of the measurement of velocity with different gate openings at Fresh Pond.

One interesting thing about these velocity diagrams, is the increased velocity apparent in them all, near the sides of the pipe, contrary to what is usually found to be the case. It is not easy to account for this. Possibly the bell mouth is too large and more water enters the mouth than can readily pass along the pipe, and so at the contracted part a quickening of the velocity at the sides takes place, until farther in the pipe a normal and uniform flow is established.

Another fact noted was that when these measurements were made the 30" gate at Fresh Pond could be run down one-half its diameter, decreasing the sectional area of the opening about two-fifths without reducing the velocity of water in the pipe. It would seem that an obstacle like the gate disk did not operate to reduce the velocity in the rest of the pipe, but rather served to quicken the velocity immediately at the obstruction to compensate for the reduced area there, somewhat as is claimed for the Venturi Water Meter. The results by this measurement of the flow, agreed quite well with the computed flow assuming a rough condition of the pipe. Thus, using the formula for compound pipes as given by E. Sherman Gould, in his little book, "Practical Hydraulic Formulæ," a flow of 8,406,700 gallons per twenty-four hours is obtained, taking the large coefficient of friction.

With the Howard Murphy formula as given in Trautwine for compound pipes and the same coefficient of friction a flow of 8,865,500 gallons daily is called for. The flow as measured by the meter was 8,066,800 gallons. It seems probable that the unfortunate profile on which the pipe was laid causing air to gather and so check the flow may account somewhat for the smallness of the meter results, also it may be that the velocity curve was reduced too much at the side of the pipe beyond the point reached by the meter. A comparison with the curves found by Mr. Freeman in hose nozzles would seem to indicate that such was the case.

DISCUSSION.

MR. TIDD. I would like to ask the gentleman if he made an experiment to ascertain at what point in closing the gate it did begin to affect the flow? There must be some point, of course, in closing the gate where it would slow the current.

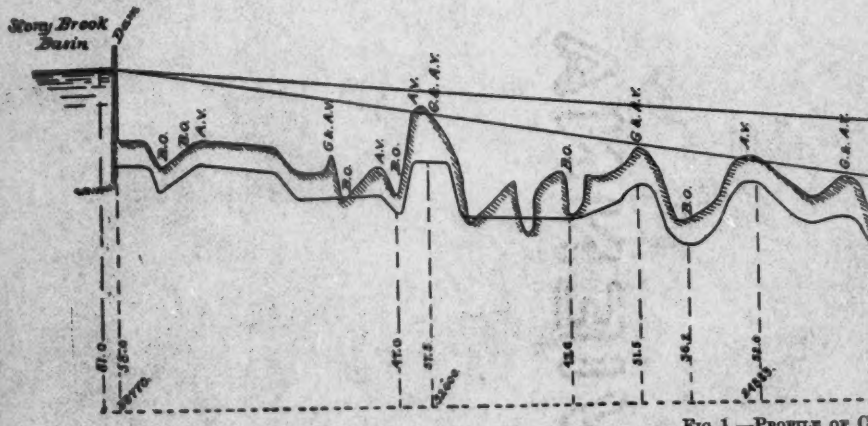
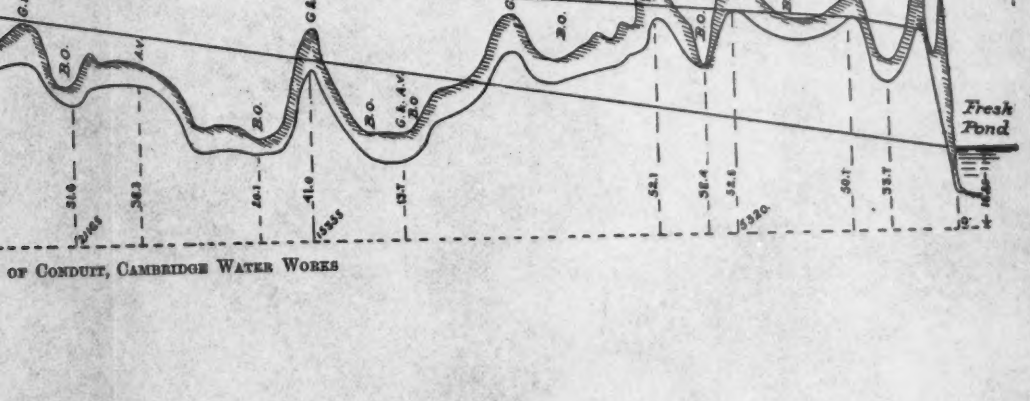
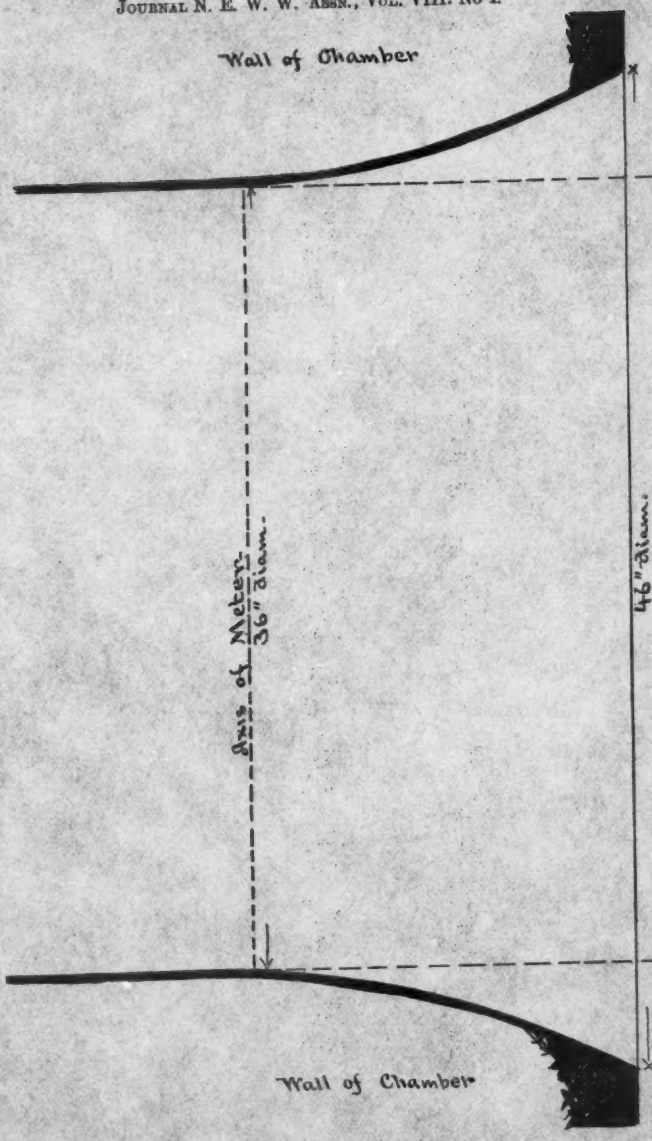


FIG 1.—PROFILE OF C



OF CONDUIT, CAMBRIDGE WATER WORKS


Wall of Chamber
Axis of Meter.
36" Diam.
46" Diam.
Wall of Chamber

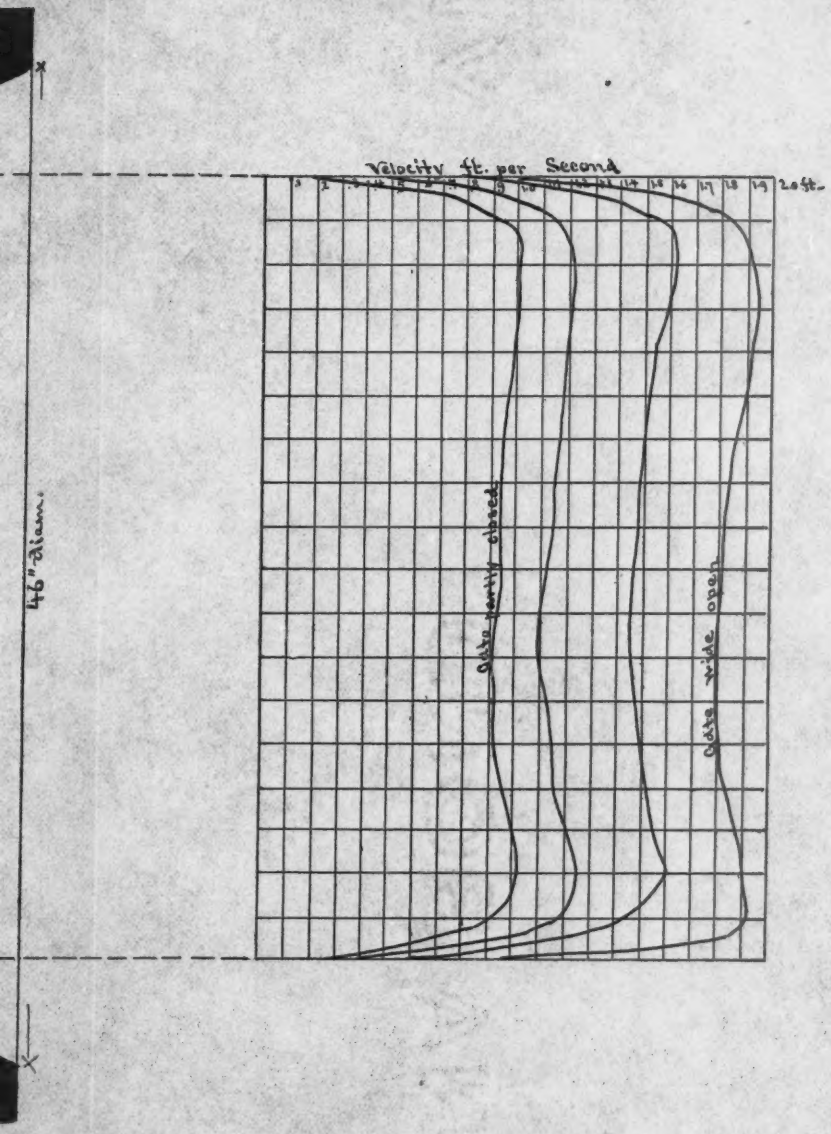

Velocity ft. per Second
2 ft.
46" diam.
Plate partly closed
Plate wide open

FIG. 2.

MR. HASTINGS. I think it began soon after the disc ran below the half-way point. I was limited in the time I could use this pipe, and so I could not make as many experiments of that sort as I would have liked to, but from those I did make I concluded that was about the point beyond which we could not shut the gate without losing water.

PROF. PORTER. Thinking that Mr. Hastings might show these interesting results that he obtained in the pipe, I ventured to bring a diagram of a few velocity curves obtained under different circumstances in the laboratory of the Massachusetts Institute of Technology.

They are plotted in the same general way that Mr. Hasting's curves are, that is, the varying distances of the curve from the reference line at the left show the varying velocities at corresponding points in the diameter of the orifice or pipe. These are from smaller orifices, as you see, and were obtained, not with a current meter, but with a Pitot tube, a very minute orifice connecting through a tube with a mercury gauge. What I wish to show by these diagrams is the way in which the friction of the orifice, or of the pipe, whatever it may be, affects the general shape of the curve. We might suppose that if there were no influence of friction from the pipe or the orifice we would have the same velocity across the whole diameter, and would have approximately a straight line running across from one side to the other. Now, in the case of a sharp-edged orifice in the side of a tank, (Fig. 3), an

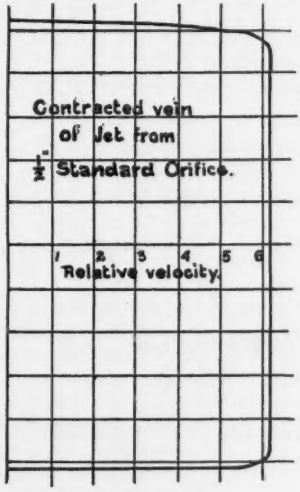


FIG. 3.

orifice which would be technically called an orifice in a thin plate, you have, it seems to me, just as little friction from the sides as you can have, and here the curve does run across nearly straight; the influence of friction is

confined to the immediate vicinity of the surface of the vein, these observations, by the way, having been taken in the contracted vein a slight distance out in front of the orifice proper.

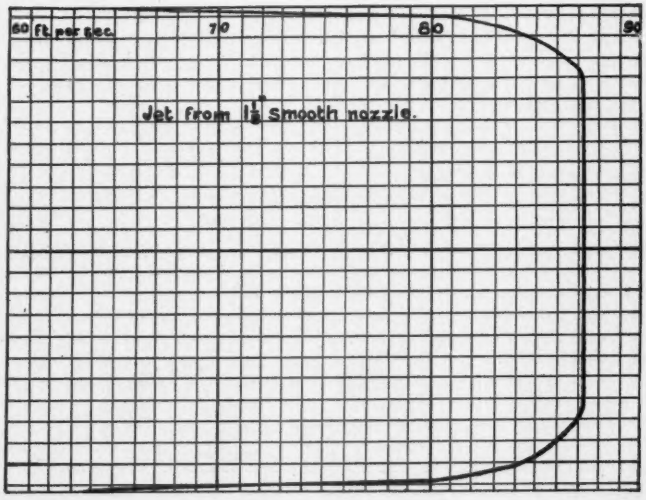


FIG. 4.

In Fig. 4 is a curve reproduced from one of Mr. Freeman's diagrams, where we have a conical nozzle. It is intermediate between a plain pipe and a standard orifice and there is a similar drawing in of the curve at the sides, under the influence of the friction, to that previously noticed.

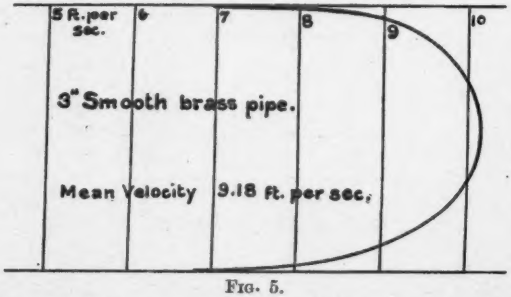


FIG. 5.

Fig. 5 is a curve which shows the way the velocity varies in the interior of a smooth brass pipe three inches in diameter, with no very great velocity

through it, the mean velocity having been 9.18 feet per second. There is a comparatively smooth curve running from the side to the centre and back on the other side.

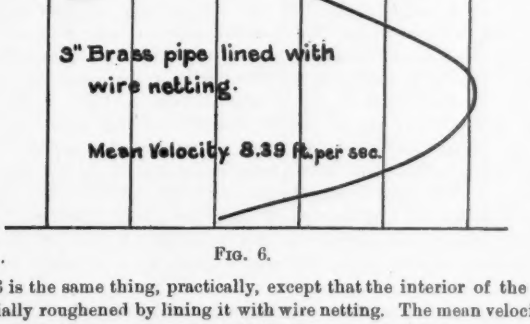


FIG. 6.

In Fig. 6 is the same thing, practically, except that the interior of the pipe was artificially roughened by lining it with wire netting. The mean velocity of the flow through the pipe was substantially the same in these two cases, but you can see a very marked change in the general shape of the curve, it being much more pointed in this case than in the former. And still another diagram of Mr. Freeman's, with water issuing from the end of an open pipe, shows a curve similar in its general shape to this. So it seems to me the general effect of friction upon the shape of the velocity curve is shown pretty well in these successive diagrams.

MR. COFFIN. I would like to ask Mr. Hastings what the distance was from Fresh Pond or Stony Brook to the highest point on the line?

MR. HASTINGS. The highest point is about 2,500 feet from Fresh Pond.

MR. COFFIN. That is, it is 2,500 feet less than the total length?

MR. HASTINGS. Yes.

MR. COFFIN. It seems to me the reason that the shutting of the pipe did not affect the delivery, is on account of the profile. Until the friction of the water through the gate plus the friction in the pipe for that distance for that amount of water, balances that difference in height; until that point is reached it won't make any difference in the flow. Perhaps I am not right about that, but that seemed to be an explanation to me of the fact. Mr. Hastings gave me the figures of the length of the pipe and his deliveries as he computed them, and as a matter of curiosity I computed them from two formulæ. One was Darcy's, and roughly speaking, I got 30 feet as the head. The efficient head is 64, as I understand it, less 28—about 36 feet.

MR. HASTINGS. If you consider this as a sealed pipe you get practically the whole head, as soon as it acts as a syphon.

MR. COFFIN. Did you consider it so?

MR. HASTINGS. I did; yes.

MR. COFFIN. The other formula I used was $v=n\,(rs)^{\frac{1}{2}}$ and would give in

this case about 25⅓ feet for friction head unless I made a mistake. I worked it roughly with a slide rule using the value of n as Hamilton Smith gives it in his book on hydraulics and in Darcy's formula, it would give about 30.5 feet, that is, for clean pipe.

PROF. SWAIN. These curves of Mr. Hastings' are very interesting to me, and it seems to me that the fact that the greater velocity occurs near the edges, may be due to the fact that the measurements were not taken far enough in the pipe to coincide with what would have been the contracted vein. I should imagine if you measured the velocity at the orifice in a thin plate, instead of measuring it in the contracted vein, as Prof. Porter did here, where the particles are all moving parallel to each other, if you should measure it right in the orifice, I should imagine the particles nearer the centre of the orifice would have greater pressure and less velocity. I should expect to find the greater velocity nearer the edge of the vein because of the pressure being less. In that way I think you could explain the fact that the greater velocity occurred near the edge, from the fact that the measurements were made nearer the orifice, one side of where the contracted vein was supposed to be.

MR. HASTINGS. The measurements were made just where the contracted vein was supposed to be, 18 inches I think it was, but at any rate right at the theoretical contracted vein.

PROF. SWAIN. That is somewhat indefinite, isn't it, just what that curve would be?

MR. HASTINGS. Yes, and that is why, I surpose, we didn't get it exactly right?

OBITUARY.

CHARLES R. DYER—Superintendent Meter Department, Water Works, Portland, Maine; sixth Vice-President of this Association for year ending June 1st, 1892. Died September 12th, 1893, aged 29 years, 3 months. Joined this Association June 11th, 1890.

THOMAS H. McLAUGHLIN—Superintendent Water Works, Texarkana, Ark. Died December 17th, 1893, aged 39 years, 1 month. Joined this Association. June 9th, 1892.

C. M. BRAINARD—Treasurer Water Works, Skowhegan, Maine. Died December 25th, 1893, aged 39 years. Joined this Association, June 12th, 1890.

WILLIAM D. TAYLOR—Superintendent Water Works, Dover, N. H. Died January 2nd, 1894, aged 45 years. Joined this Association December 14th, 1892.

WEAVER OSBORN—Member of Water Board from May, 1878, to May, 1893. Fall River, Mass. Died February 3rd, 1894, aged 78 years. Joined this Association, June 17th, 1887.

New England Water Works Association Membership Roll.

June 1, 1894.

NOTE.—The secretary requests to be advised of existing errors or changes of address from that which appears in the following list.

ACTIVE MEMBERS — RESIDENT AND NON-RESIDENT.

Abbott, Everett L.
29 Broadway, Rooms 196 and 197, New York city.

Allen, Charles A.
Civil Engineer, 44 Front street, Rooms 109 and 110, Worcester, Mass.

Allen, Charles F.
Treasurer, Hyde Park, Mass.

Allis, Solon M.
Civil Engineer, Madison, N. J.

Andrews, Frank A.
Assistant Superintendent, Nashua, N. H.

Ayres, Henry W.
Chief Engineer, Hartford, Conn.

Babbidge, P. F.
Superintendent, Keene, N. H.

Babcock, Stephen E.
Chief Engineer, Little Falls, N. Y.

Bacot, R. C., Jr.
Superintendent Meter Department, Hoboken, N. J.

Bagnell, Richard W.
Superintendent, Plymouth, Mass.

Bailey, George I.
Superintendent, 61 State street, Albany, N. Y.

Baldwin, Charles H.
Box 2410, or 159 Franklin street, Boston, Mass.

Baldwin, Richard
Proprietor Water Works, Terryville, Conn.

Ball, Phinehas
Civil Engineer, Worcester, Mass.

Bancroft, Lewis M.
Superintendent, Reading, Mass.

Barbour, Frank A.
Civil Engineer, P. O. Box 1235, Brockton, Mass.

Barns, Everett
Superintendent, Westerly, R. I.

Barrett, Albert P.
Water Registrar, Woburn, Mass.

Barrus, George H.
Consulting Steam Engineer, 95 Milk street, Boston, Mass.

Bartlett, Charles H.
Civil Engineer, 852 Elm street, Manchester, N. H.

Bassett, Carroll Ph.
Civil Engineer, National Bank Building, Orange, N. J.

Batchelder, George E.
Registrar, Worcester, Mass.

Batcheller, Francis
Commissioner, North Brookfield, Mass.

Bates, Theodore C.
Chairman Water Commissioners, North Brookfield. Address, 29 Harvard street, Worcester, Mass.

Battles, James M.
120 Marginal, cor. Cottage street, East Boston, Mass.

Beals, Joseph E.
Superintendent, Middleboro, Mass.

Benzenberg, G. H.
City Engineer, Milwaukee, Wis.

Berkey, John A.
Pres. Electric and Water Co., Little Falls, Minn.

Bickford, Nathan B.
Superintendent Water Works, O. C. System N. Y., N. H. & H. R. R., Boston, Mass.

Billings, William R.
15 Harrison street, Taunton, Mass.

Birkinbine, Harry
Civil Engineer, Wayne, Delaware County, Penn.

Bishop, George H.
Civil Engineer, Middletown, Conn.

Bishop, Watson L.
Superintendent, Dartmouth, N. S.

Blossom, William L.
Civil Engineer, 355 Washington street, Brookline, Mass.

Boggs, Edward M.
Professor of Civil and Hydraulic Engineering, University of Arizona, Tucson, Arizona.

Bolling, Charles E.
Superintendent, Richmond, Va.

Bowers, George
City Engineer, Lowell, Mass.

Brackett, Dexter
Assistant Engineer, City Engineer's office, City Hall, Boston, Mass.

Bradley, R. H.
First Engineer, Watertown, South Dakota.

Brinsmade, Daniel S.
Engineer and Agent Ousatonic Water Co., Birmingham, Conn.

Broatch, J. C.
Superintendent, Middletown, Conn.

Brown, Arthur W. F.
Registrar, Fitchburg, Mass.

Brown, Edward H.
Superintendent and Treasurer Nevada County, N. G. R. R., Grass Valley, Cal.

Brown, J. Henry
3 Tremont street, Charlestown, Boston, Mass.

Brown, Milton A.
Superintendent, Perth Amboy, N. J.

Brownell, Ernest H.
Brown University, Providence, R. I.

Brush, Charles B.
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Bucknam, Geo. A. P.
Superintendent, Norwood, Mass.

Burleigh, John M.
Superintendent, South Berwick, Maine.

Burley, Harry B.
31 Milk street, Room 55, Boston, Mass.

Burnham, Albert S.
Superintendent, Revere, Mass.

Burnie, James
Superintendent, Biddeford, Me.

Burr, William H.
Professor of Civil Engineering, Columbia College, and Consulting Engineer, New York city.

Butler, J. Allen
Superintendent, Portland, Conn.

Carroll, Fred. B.
8 Dexter street, Woonsocket, R. I.

Cavanagh, John T.
Water Commissioner, Quincy, Mass.

Chace, George F.
Superintendent, Taunton, Mass.

Chadbourne, E. J.
Superintendent, Wakefield, Mass.

Chaffee, Fred. I.
Superintendent, East Providence Center, R. I.

Chandler, Charles E.
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Chandler, Charles F.
Professor of Chemistry, School of Mines, Columbia College, New York city.

Chase, John C.
Superintendent, Wilmington, N. C.

Childs, Wm. H.
6 Harrison street, New York city.

Clark, D. W.
President Water Company, Portland, Me.

Clark, Ezra
President and Superintendent, Hartford, Conn.

Clark, Frederick W.
Clerk, Chestnut Hill Reservoir, Boston, W. W., Brighton, Mass.

Clark, Harry W.
State Experiment Station, Lawrence, Mass.

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JOURNAL

OF THE

New England Water Works

ASSOCIATION.

VOLUME VIII.

September, 1893 to June, 1894.

PUBLISHED BY

BOARD OF EDITORS.

Junior Editor's Office, New London, Conn.

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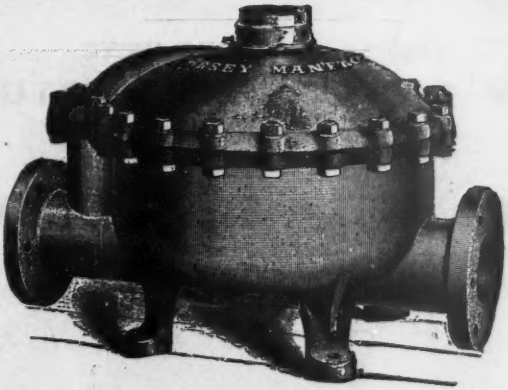

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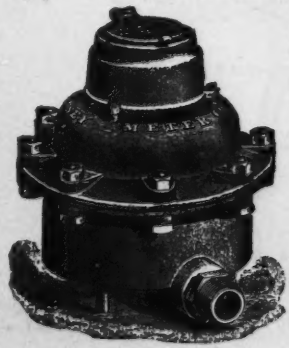

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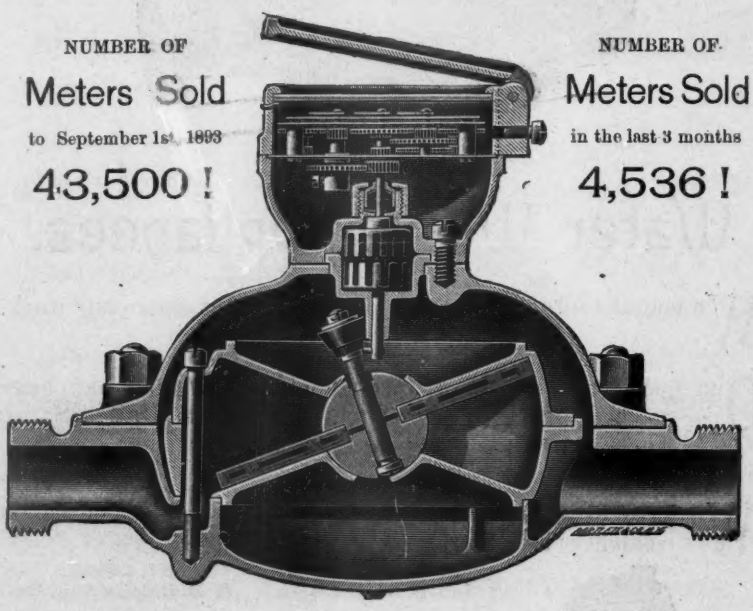

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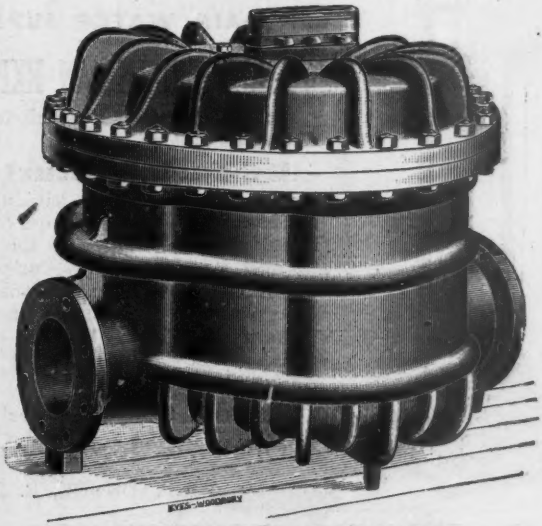

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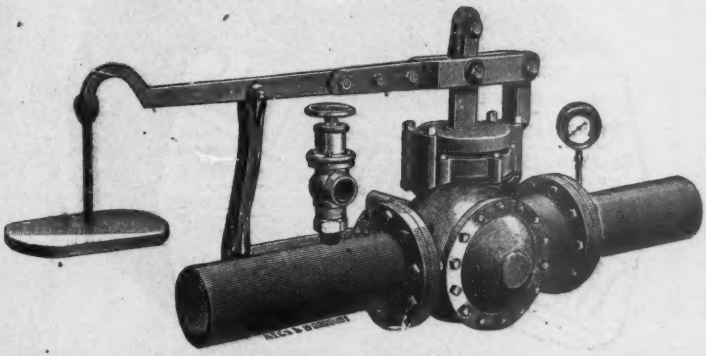

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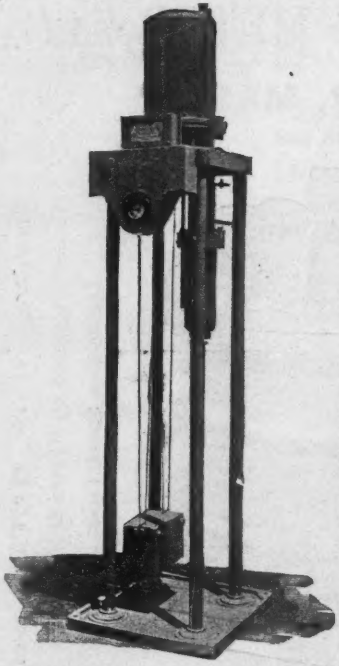

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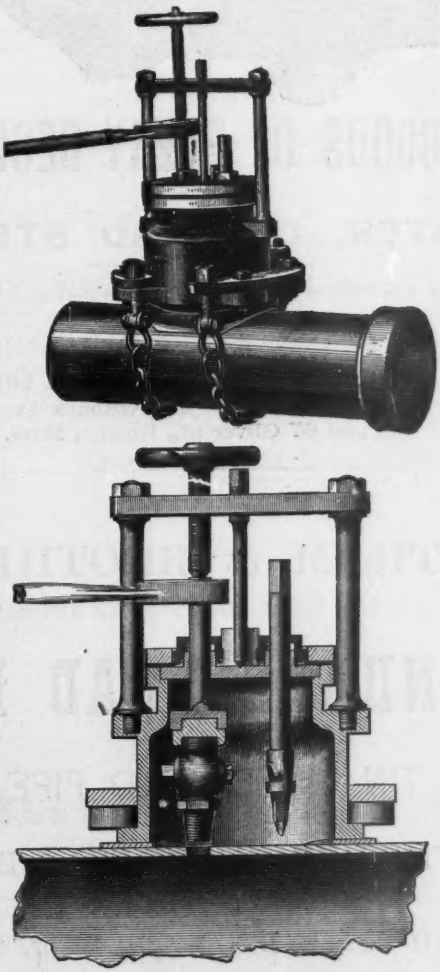

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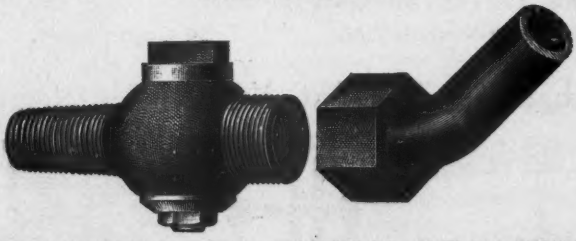

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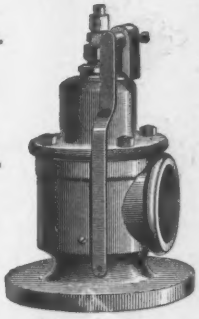

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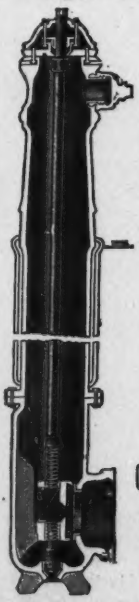

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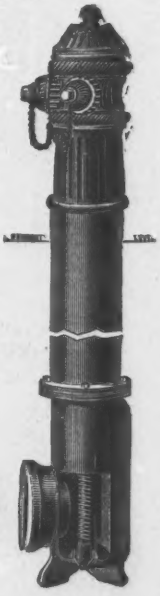

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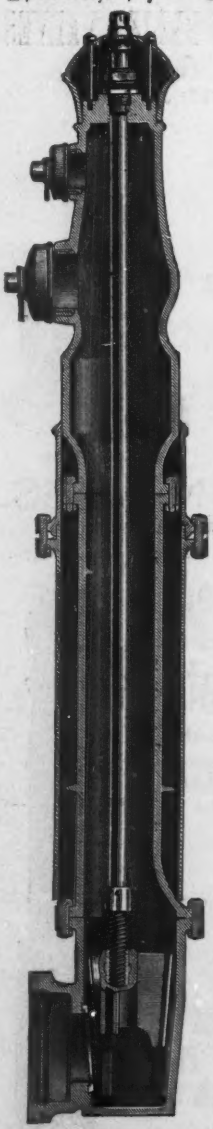

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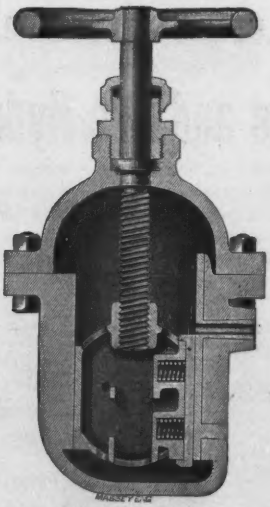

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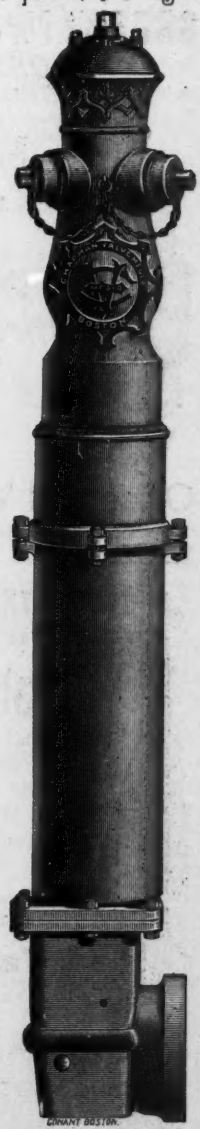

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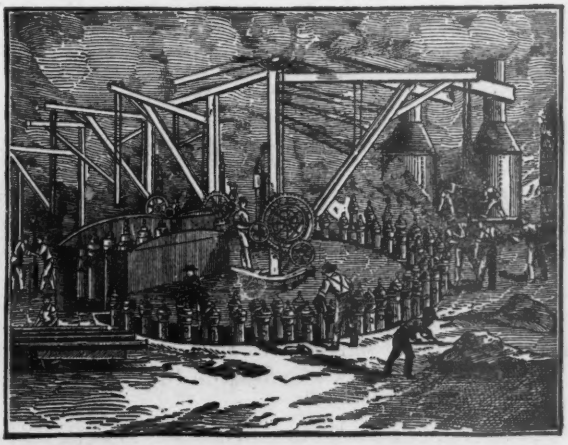

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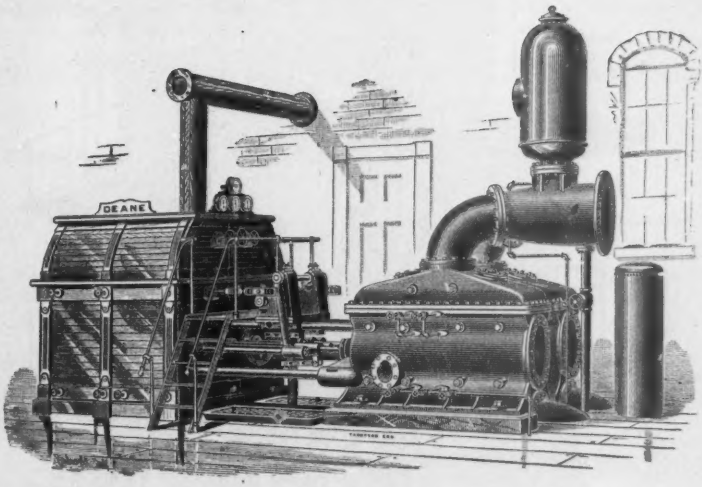

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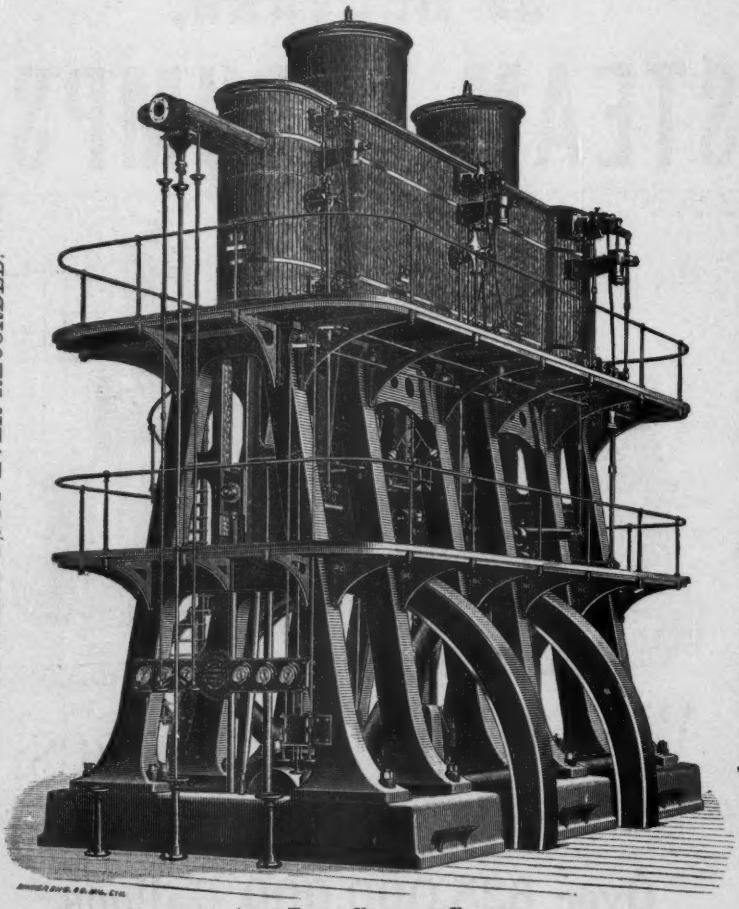

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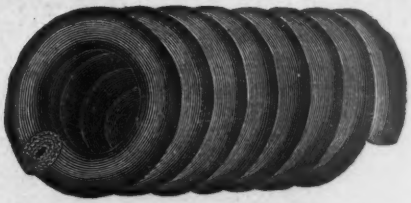

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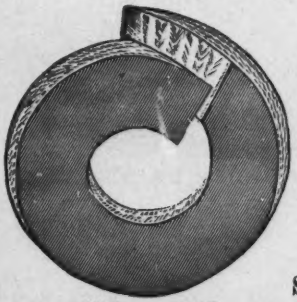

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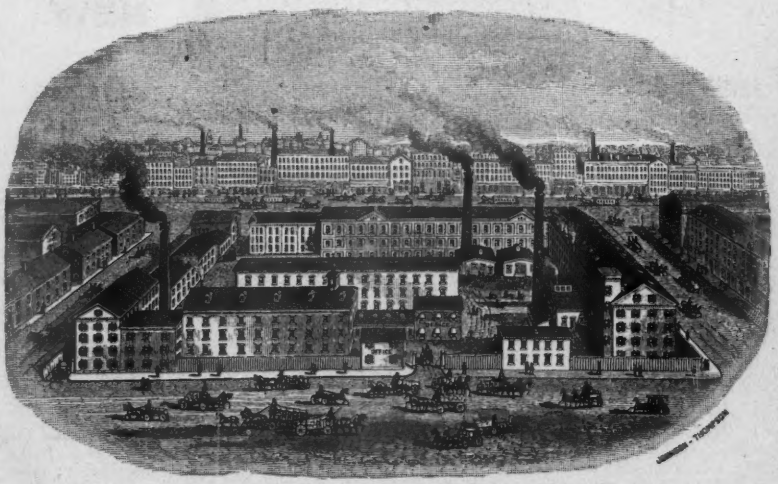

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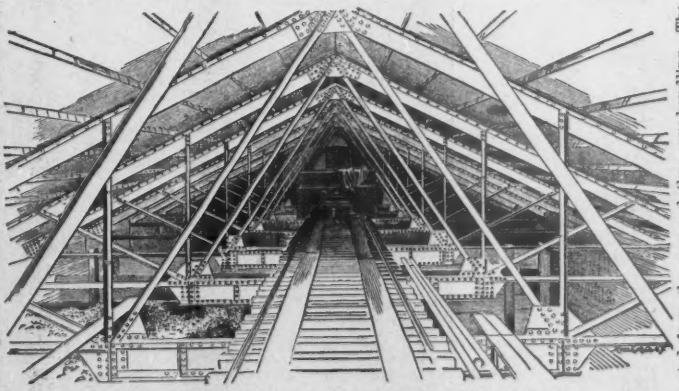

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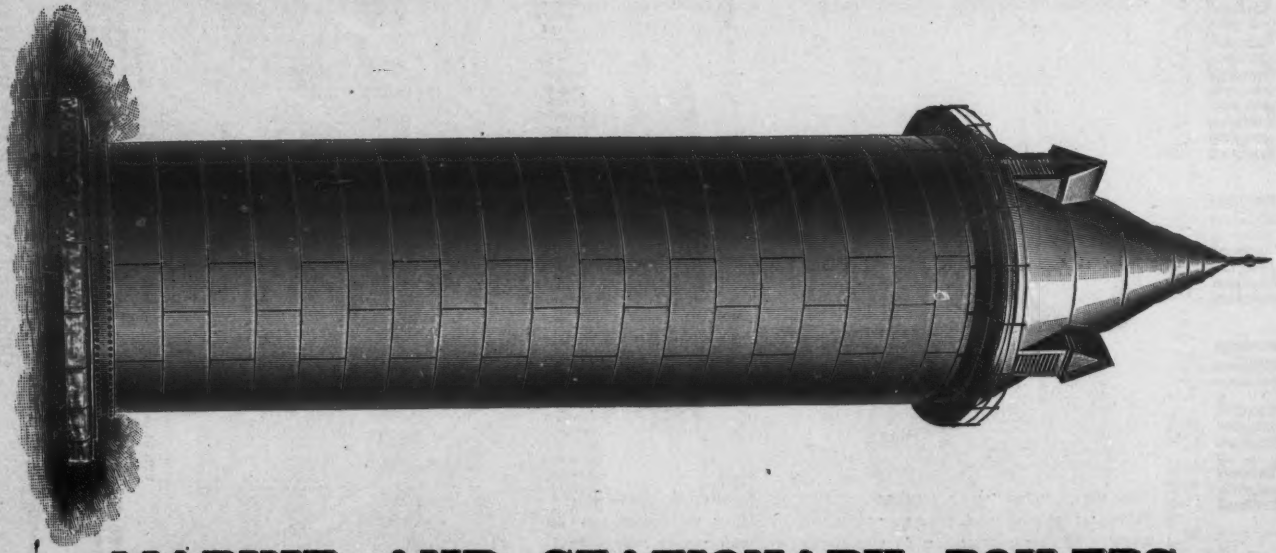

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The New England Water Works Association

was organized in Boston, Mass., on June 21st., 1882, with the object of providing its members with means for social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only twenty-seven, its growth has prospered until it now includes the names of over 400 men. Its membership is divided into two principal classes, viz.: Active and Associate. The active membership is further divided into two classes, viz.: Resident and Non-Resident,—the former comprising those residing within the limits of New England, while the latter class include those residing elsewhere. The initiation fee for the former class is five dollars; for the latter three dollars. The annual dues for both classes of Active membership is two dollars. The Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for Associate membership is ten dollars, and the annual dues ten dollars. This Association has four regular meetings each year, also a series of informal monthly meetings, during the winter months at Boston, Mass.

The Journal of the New England Water Works Association

is a quarterly publication, containing the papers read at the meetings, together with verbatim reports of the discussion. It also contains interesting contributions from writers of the highest standing in their profession. It affords a convenient medium for the interchange of information and experience between its members, who are so widely separated as to find frequent meetings an impossibility. Its success has more than met the expectation of its projectors; there is a large and increasing demand for its issues, and every addition to its subscription list is a material aid in extending its field of usefulness. All members of the Association receive the Journal in return for their annual dues; to all others the subscription is two dollars per annum.

The Secretary would be pleased to give further information to any one desiring the same. Address,

R. C. P. COGGESHALL,
Secretary New England Water Works Association,
New Bedford, Mass.